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ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JULY 20, 1939

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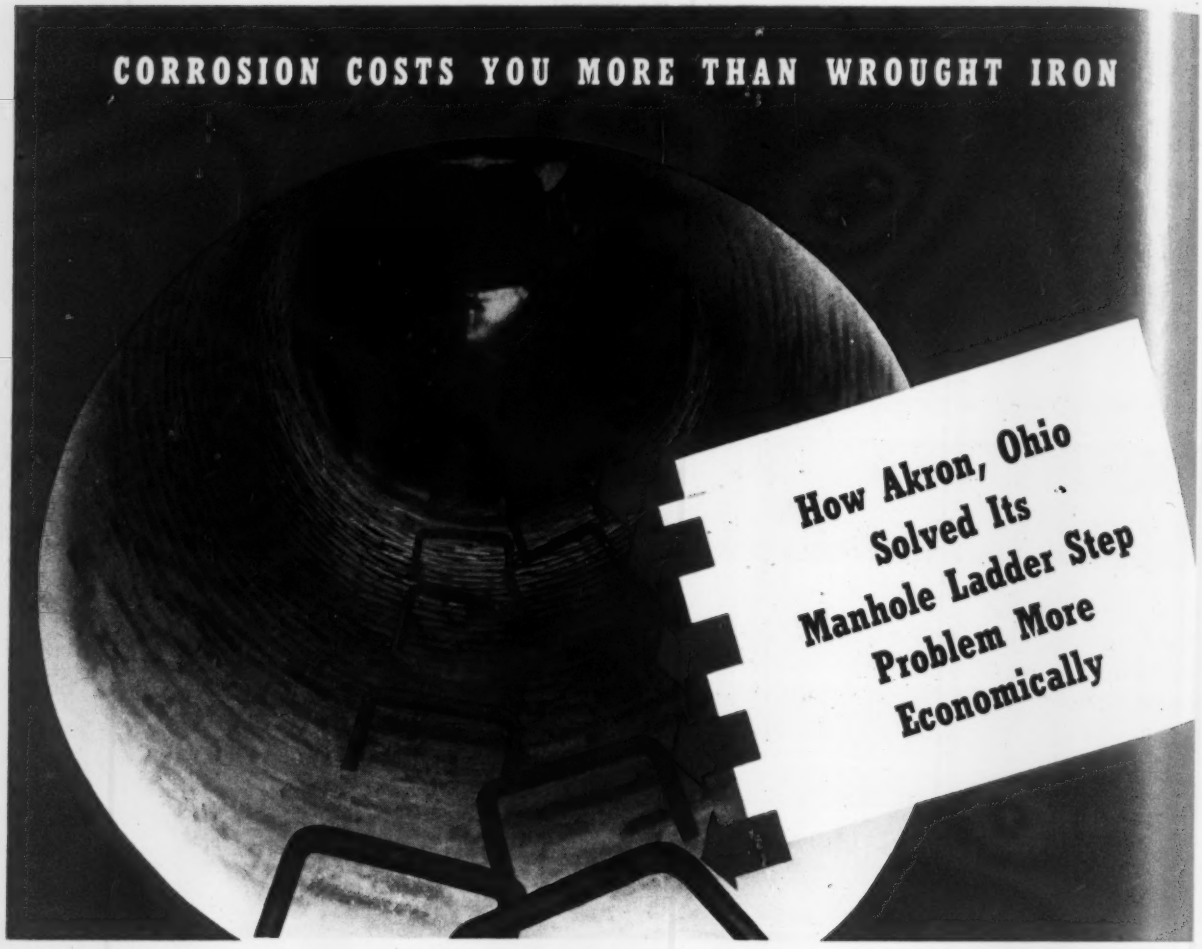

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Decrease of structural strength due to corrosion is of special importance in manhole ladder steps. Failures which would cause accidents can only be avoided by constant inspection and frequent replacement . . . or through the use of a material of proven dependability and life.

The problem is so serious that some municipalities have used extremely expensive materials. Others, like the Sewage Department of the City of Akron, do the job at one-tenth the cost, with wrought iron. San Francisco, California, Cleveland, Ohio, and Kansas City, Missouri, are a few of the other cities also using wrought iron in this service.

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigations, Canals, Railroads

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Vol. 123 | *July 20, 1939* | No. 3

	PAGE
The Week's Events	35–88
Reader Comment	42
Editorials	44
The Merritt Parkway	46
A Brewery Waste Treatment Plant	49
Why Not More Accurate Bid Plans?	50
Water Distribution Hazards	51
Driver for Batter Piles	52
End Spans for Big Creek Bridge	53
Low Cost in Low Cost Housing — ELWYN E. SEELYE	54
Water Treatment for 100 Consumers	57
Devices for Sampling Undisturbed Soil	58
Rigid Frame Bridge Design	60
Stress, Strain and Structural Damage — H. F. MOORE	61
A New Soil Compacting Device — S. STEUERMANN	63
Vacuum Frequency and Cross Connections — A. B. CRONKRIGHT AND A. P. MILLER	64
A Bold Arch Center — H. KAEGI AND A. J. LUCHINGER	66
Progress in Construction Materials	68
Protective Tip for Ventilating Pipes	72
Thin-Shelled Dome at World's Fair — H. ALDEN FOSTER	73
High-Voltage Cables to a Dredge	74
Intercepting Devices for Sewers — ALFRED WICKESBERG	75
Rumination on Pavement Joints — H. J. GILKEY	77
From Field and Office	78
Book Notes and Reviews	79
Contract Unit Prices	84
New Aids to the Constructor	94
Construction Reports	125

THIS WEEK

TWO WEEKS AGO in *ENR* Fred N. Severud discussed means of avoiding cracks in building walls. He explained the crack-forming phenomenon as a function of concrete floor slab shrinkage. This week Elwyn E. Seelye, as a part of his article on New York's Queensbridge Houses, presents his theory, which is not unlike Severud's except that it goes farther and explains why the cracking is greater than what would seem logical i.e., because it is cumulative. Shrinkage creates the cracks, and during subsequent expansion the cracks do not close, so that a later shrinkage opens the cracks wider.

THINGS TO COME

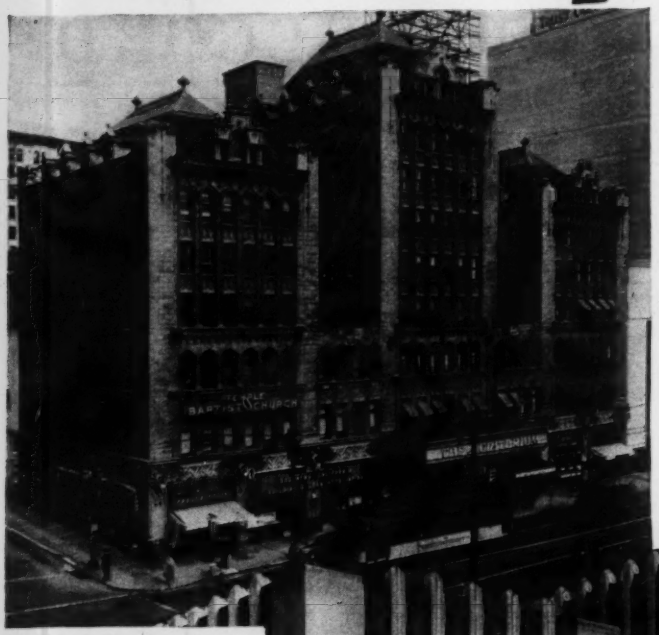
● Open caissons designed for a flotation depth of 100 ft. signalize the foundation work of the Bronx-Whitestone suspension bridge recently opened for traffic in New York City. Design details of these caissons and experience in sinking them in East River silt will be told in an article in the Aug. 3 issue by George L. Freeman.

● Brig. Gen. Harley B. Ferguson retires as head of the Mississippi River Commission next month. An authoritative article in the Aug. 3 issue will review the flood control and regulatory work on the lower river that was the subject of major policy changes under his administration.

● Use of thickened-edge pavements, now a widely accepted practice, is questioned by W. S. Downs in an article to be published soon. Prof. Downs characterizes this practice as unrealistic design.

● John M. Carmody, Federal Works Agency head has prepared a statement for the Aug. 3 issue of *Engineering News-Record* in which he outlines the plans and policies so far formulated for this new federal public works department.

BEFORE STUCCO



Modernizing miracle transforms noted Los Angeles Auditorium

THE REMODELING of this center of business and culture in Los Angeles is a tribute to architects and builders of today—and the modern materials they use.

Stucco is one of these materials. Here, it is factory-prepared stucco made with Atlas White portland cement which wraps this Auditorium in a modern, permanent, fire- and weather-resisting wall.

Consider Atlas White stucco for your next modernizing job and for new buildings. You can specify it in white and a range of colors. Both initial and maintenance costs will be surprisingly low. Let us send you information on the many ways in which stucco is being used today. Write Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, N.Y.C.

A FACTORY-PREPARED STUCCO IS PREFERABLE

AFTER STUCCO

●California Stucco, made with Atlas White and produced by the California Stucco Co. of Los Angeles, helped work a modernizing miracle on the Los Angeles Auditorium. Architect: Claud Beelman; General Contractor: the Baruch Corp.; Plastering Contractor: W. D. Lindsay, Jr.;—all of Los Angeles.

NR-S-4

STUCCO MADE WITH **Atlas White** PORTLAND CEMENT

ENGINEERING NEWS-RECORD

NEWS

Volume 123 JULY 20, 1939 Number 3

Both Sides Firm In WPA Strike

Administration rejects any concession to skilled workers elimination of prevailing wage

With the strike of WPA workers seeking restoration of prevailing hourly wages on WPA projects midway in its second week, neither the government nor the unions showed any important signs of yielding. The administration has made plain its lack of sympathy with the objectives of the strikers; Work Projects Commissioner Harrington has ordered local administrators to drop from the WPA rolls strikers absent from work more than five days, and President Roosevelt, expressing his disapproval of the strike, said that "You cannot strike against the government."

The only government move in support of the strikers came from a group of Senators led by Senator Murray of Montana who introduced legislation to restore the prevailing wage provision. Although it was announced last week that the group had given up hope of Congressional action, Murray said July 17 that he was still working on the bill and would insist that the appropriations committee hold hearings on it. Informed opinion in Washington, however, give the legislation little chance.

(*Continued on p.* 41)

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Lottery May Finance Chicago Housing

A bill which would create a state-supervised lottery to raise funds for Chicago slum clearance housing projects was placed before Governor Horner July 13. The proposed law would permit tickets to be sold to the public and each buyer would become a member in the Illinois Home Building Corp. as set up by the bill. There would be drawings each month, with 10 per cent of the receipts set aside for ten winning tickets.

Mathieu

COMBINED OFFICE AND GARAGE

NEW YORK CITY'S first combined office building and garage, the Netherlands Building, was opened June 28 in Rockefeller Center. The parking space occupies six levels, three of which are underground, and accommodates 800 cars. A special permit was required to include the garage in the building, as the New York building code which now permits such construction was not effective until January 1.

FHA Housing Program Gains 80 Per Cent

Construction of new homes under the FHA program during the first six months of 1939 showed a gain of approximately 80 per cent over the corresponding period of 1938, according to information released in Washington.

Since March 1 an average of more than 500 houses have been started under FHA inspection each working day. Virtually all these houses are small single-family homes valued at an average of about $5,500. In the first half year, small home mortgages selected for appraisal by the FHA amounted to $602,000,000 as compared with $455,200,000 in the first six months of 1938, an increase of 32 per cent.

Yadkin River Held Not Navigable

High Point project licensed by FPC is ordered halted by state court

The Yadkin River in North Carolina is not in any sense navigable, North Carolina Superior Court held June 30, and the City of High Point therefore may not build a $6,500,000 hydroelectric project on the river under authority of a license granted by the Federal Power Commission. The court ordered the city to stop all work on the project, on which more than $3,000,000 in contracts has already been let and preliminary work has begun.

The city, the court held, should have obtained authorization for this project from the North Carolina Commissioner of Public Utilities. Moreover, it was held that the bond issue which the city plans must be approved by a vote of the citizens.

Legality of the High Point project was attacked in two suits, one brought by the Duke Power Co. and a number of High Point citizens which attacked the federal authorization, and another brought by Yadkin County contesting the city's right to condemn land to create a reservoir. The county was upheld in the latter suit.

The State of North Carolina had intervened in the case, charging that the Federal Power Commission was attempting to invade the state's sovereignty when the commission held that the Yadkin was navigable.

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Five Day Week Adopted At Grand Coulee

Construction of Grand Coulee Dam has been slowed up with institution of a 5-day week by the Consolidated Builders Corp., contractors for the dam. Officials said that the change from the 6-day pouring schedule to 5 days was made because of lack of cement supplies to carry on the previous schedule.

(Vol. p. 59)

Army Again Rejects Battery Bridge

War Departments considers structure potential war hazard to Navy Yard upstream

The War Department on July 17, for a second time, rejected plans for a proposed bridge in New York City across the mouth of the East River between the Battery on Manhattan Island and Brooklyn. Secretary of War Harry H. Woodring stated, concerning the rejection: "The proposed bridge is seaward of a vital naval establishment. Two bridges now span the East River seaward of the United States Navy Yard at Brooklyn and numerous port facilities. The bridges are actually potential hazards to access between the sea and these facilities in the event of an emergency.

"The War Department is unable to approve the construction of a bridge . . . if the destruction of such a bridge in time of war might block access from the sea."

Robert Moses, chairman of the Triborough Bridge Authority, commented: "The decision was not altogether unexpected. In the course of a fairly long experience with major public improvements I have rarely seen anything like the kicking around, discourtesy and insulting treatment which this application and its sponsors were accorded at Washington. We took it because we were more interested in the project than in our own personal pride.

"From the very beginning it was clear that this application was not being considered on its merits, and that instructions had been given to decent, honorable army men down the line in the War Department to hold it up and to await a decision on the higher strategy. The higher strategy had for its object the blocking of this project on some basis which would not disclose the real motives.

"It is obvious that the defense of the nation will not be impaired by the building of the Brooklyn Battery Bridge on the location suggested to us by the army engineers who ordinarily pass on such projects and at a location which the present head of the Brooklyn Navy Yard declared to be entirely satisfactory to him."

The first rejection came in May when the War Department rejected the proposed bridge on the score that the tandem suspension layout would require construction of two main piers and a joint anchorage in the East River near Governors Island which would constitute an unreasonable obstruction to free navigation. (See *ENR* May 25, 1939, p. 45.)

When this rejection was made known, new plans were drawn to give increased channel width on the Manhattan side, the 150-ft. vertical ship clearance being retained. The new changes were expected to raise the cost from $41,200,000 to $44,000,000. The New York City Tunnel Authority has the power to build a tunnel on the same alignment site and plans are now being revived.

• • •

Weinfeld Named to Head New York State Housing

Edward Weinfeld, New York City attorney, has been appointed superintendent of the New York State Division of Housing, a new agency created under 1939 legislation to administer the state's $300,000,000 low cost housing program approved by constitutional amendment last fall. This program is the only state-financed housing program in the country.

Under the new housing law which became effective July 1, Weinfeld will approve plans and control all slum clearance and housing projects undertaken by the state or any other political subdivision and will supervise activities of the private housing companies authorized under the new law.

The 1939 law provides that $150,000,000 of the $300,000,000 authorized in the state constitution be loaned to local housing authorities over the next three years. In addition, rent-reducing subsidies will be made.

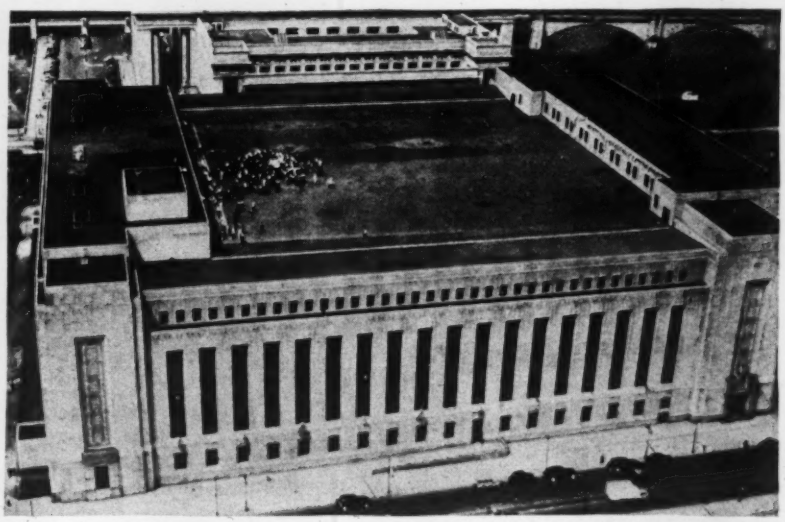
Turnpike Time Extension Avoids Winter Work

A 60-day extension of the deadline for completion of the Pennsylvania turnpike being built between Harrisburg and Pittsburg by the Pennsylvania Turnpike Commission, has been approved by the PWA, which with RFC is financing the highway. The turnpike must now be completed by June 29, 1940.

The contract time extension was granted to enable the commission to extend paving operations in the winter months. Orginally, May 1, 1940 was fixed as the completion date in the PWA grant agreement.

More paving bids asked

The commission meanwhile is continuing advertising for bids for paving sections that are completely settled, and expects to pave a total of about 50 miles of highway this year. To date, the commission has opened bids on a total of about 153 miles of grading and drainage, together with construction of the seven tunnels that will carry the super highway through the Appalachians. Bids have also been received on about 17 miles of paving. The commission has readvertised a 6.7 mile paving section on which bids were open July 7, with revised specifications permitting the contractors to defer more than half of the paving until next Spring, thus taking advantage of the new time extension.



Wide World

POST OFFICE ROOF USED BY AUTOGIRO

REDUCING the time for mail to be delivered from the Camden airport six miles away from 40 minutes by truck to 6 minutes by air, autogiros loaded with mail now land on the roof of the Philadelphia post office. Service was begun this month and a round trip requires about 14 minutes. The building, whose roof was designed for airplane loads, is a five-story steel frame structure 370 x 460 ft. in plan. (See *ENR*, Dec. 28, 1933, p. 787).

Niagara Falls Bridge Not Started In Time

War department rules that borings do not constitute start of construction

Because preliminary borings for its new bridge across the Niagara River have been held by the War Department not to constitute an actual start of work on the bridge, the Niagara Falls Bridge Commission is now left without congressional authorization to build an international bridge to replace the old Falls View Bridge wrecked by ice in January 1938. Construction of the bridge was authorized by Congress in an act, passed last year, which also permitted financing of the structure by issuance of tax exempt bonds. However, when the deadline for the beginning of construction passed, no work had been done except borings.

A bill to extend the time limit for starting construction was passed by Congress last month, but the President vetoed it because he disapproved of the tax exempt bond provision in the original bill. The President said that he would sign a new authorization bill if it eliminated the tax exempt bond feature. Such a bill has passed the House.

The Niagara Falls Bridge Commission is anxious to build its bridge under the original authorization because of the lower cost of tax exempt financing.

Tunnel Work Resumed Pending Labor Parleys

Work on the Queens Midtown Tunnel in New York City and on several sections of the Delaware River Aqueduct was resumed after 2½ weeks of strikes and walkouts occasioned by attempts of Local 147, sandhogs working on the Queens project, to gain a foothold on the aqueduct work now held by Local 60 of the same international union of hodcarriers and construction workers. Details of the trouble were given in these pages last week. On July 17 Local 60 brought court action in Westchester County against Local 147 to enjoin the latter from picketing and interfering with the aqueduct tunnel work. During the hearing the two locals agreed to arbitrate jurisdiction over the water tunnel; meanwhile Local 147 was to limit picketing to one man at each shaft, and both locals promised to avoid violence.

On July 18 Walsh Construction Co., Queens tunnel contractor, sued in a New York court to force Local 147 to return to work under its agreement with the contractor. At a hearing on this action, the sandhogs agreed to return to work Wednesday morning pending the outcome of arbitration on the aqueduct tunnel. As the Walsh contract is the key to completion of the Queens tunnel project, opening of the tunnel will be delayed because of time already lost from strikes and other causes.

Carmody Discusses Works Agency

Washington engineers give luncheon for new head of Federal Works Agency

The new Federal Works Agency, which began functioning the first of this month, falls only a little short of the department of public works for which there has been strong sentiment in the engineering profession for nearly a quarter of a century, it was pointed out by speakers at a luncheon tendered July 14 by Washington engineers to John Carmody, the new federal works administrator. The speakers at the luncheon, which was arranged by John Hoyt of the U. S. Geological Survey, were representatives of the five organizations that make up the works agency. Don H. Sawyer, president of the Am. Soc. C. E., was toastmaster.

Carmody said that most of his time, since he took over his new post, had been spent in sessions with the appropriations committees of congress. He called attention to the fact that there is nothing in college courses in engineering fitting a graduate to appear before a hostile appropriations committee. Carmody said he had had little time to do any planning, but that he was certain his staff would be very small, and that most of the work would be done through existing agencies.

E. W. Clark spoke for the Public Works Administration, Jacob Crane for the U. S. Housing Authority, Perry Fellows for the Works Project Administration, W. E. Reynolds for the Public Buildings Administration, and Thomas H. MacDonald for the Public Roads Administration. About 150 engineers attended.

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Colorado River Compact Criticized by California

California's Colorado River Board has recommended to the state legislature the rejection of Arizona's proposed tri-state Colorado River compact. The proposed compact would divide all the Colorado River water in the lower basin between the states of Arizona, California and Nevada.

In a letter to Gov. Culbert L. Olson, the board pointed out that the Arizona compact already has been enacted into law by the Arizona legislature, thus denying California and Nevada any opportunity for negotiation. The California board charged that Arizona took the liberty of adding new language to the tri-state compact, part of the Boulder Canyon Project Act of 1928, greatly enlarging Arizona's rights.

Bureau of Reclamation

OFFICIALS INSPECT RAILWAY RELOCATION AT SHASTA

RECLAMATION officials and engineers pause at the entrance of a tunnel in their inspection of the relocation of the Southern Pacific Ry. at Shasta Dam, of California's Central Valley project. They are, left to right: R. S. Calland; Walker R. Young, supervising engineer, Central Valley project; Ralph Lowry, construction engineer, Kennett Division; J. P. Densmore; and D. A. Rankin, vice-president of the West Construction Co. of Redding, Calif.

Research and Policing Held Housing Aids

Summary by monopoly committee expert emphasizes breadth of problem to stimulate housing

Monopolistic and conspiratorial practices by almost all elements in the construction industry were emphasized as a major element in the high cost of housing construction by Assistant Attorney General Thurman W. Arnold, testifying at hearings before the Temporary National Economic Committee, popularly known as the Monopoly Committee (*ENR* July 6, 1939, p. 1). A different note was struck later in the hearing when Robert D. Daveson, housing research director of the John B. Pierce Foundation, estimated that an adequate research program on housing technique could halve the cost of housing within two years.

Arnold's testimony followed closely his speech before the New York Building Congress, which is summarized in *Engineering News-Record* of July 6, and which proposed enforcement of the anti-trust laws in relation to building construction on a nationwide scale.

Labor costs discussed

A number of following witnesses confirmed Arnold's remarks by detailed discussions of their own experiences in building. They included Robert E. Wood, chairman of the board of Sears Roebuck & Co., and Gerhardt F. Meyne, Chicago contractor. These witnesses emphasized particularly the difficulties caused by high rates and restrictive rules of labor unions.

Attacking the latter point of view, Dan W. Tracy, president of the International Brotherhood of Electrical Workers, said that 90 per cent of residential construction work is done by non-union labor and added that in 1938 labor costs represented only 35 per cent of the cost of building as compared with 50 per cent in 1932.

The contention that labor costs are an important obstacle to housing was also attacked by Theodore J. Kreps, economic consultant, in his final summary of the testimony. Kreps said that a one per cent drop in the rate charged for money invested in housing would have more effect on costs than a 50 per cent cut in the wages of construction labor at the site.

Little hope for substantial reductions in interest rates was held out by Henry Bruiere, president of the Bowery Savings Bank of New York. Bruiere said he did not believe a small reduction in rates would do much to stimulate the market for low cost housing and that it would not be easy to sell mortgages yielding much lower interest than at present.

Robert D. Daveson displayed samples of new types of building materials which he said could be adapted to housing construction. He said that a comparatively limited amount of research has already demonstrated the possibilities of cutting building costs but that outmoded local building codes and the reluctance of the building materials industry to displace its present products are holding up the application of a dozen available new materials.

The building codes of most municipalities, he said, were drawn up during the "masonry days" and generally require too much strength in materials and structures. Davison favored some plan whereby the building materials industry would establish special prices for materials sold to produce "packaged houses" He also urged creation of a federal board to stimulate government housing research in cooperation with industry.

Reduction in the construction costs of houses was also urged by John Fahey, chairman of the Federal Home Loan Bank Board. Fahey said that substantial economies had already been effected in financing costs and that the further reductions in costs which were needed must be made in the actual cost of construction and in the service charges which accompany the purchase and sale of houses.

Testimony summarized

In a summary of the testimony, which he emphasized represented his personal views rather than those of the committee, Theodore J. Kreps pointed out that the housing problems are merely phases of a number of general problems affecting the entire national economy and can only be solved as the ills of the national economy are cured. At the same time, he said, the testimony indicated that many of the problems are definitely local and can best be attacked by municipalities. He suggested a considerable number of steps that local governments could take, largely directed toward better use of land, improvement of building and housing codes and more strict enforcement of local housing laws. Another important step which he held was indicated by the testimony is that of "coalescing and integrating the crafts and enterprises euphemistically called a home building industry," by "encouraging the formation of large building companies."

Wide World

PARKCHESTER APARTMENTS OPEN THIS FALL

RAPID PROGRESS marks construction of Parkchester, largest housing project in the United States, which is being built by the Metropolitan Life Insurance Co. in the Bronx, New York City. First units are expected to be ready for occupancy this fall. Financed by the insurance company without benefit of any subsidy, as permitted by recent amendment to the state insurance laws, the project will provide housing for 12,269 families at rentals of $12 to $15 per room. Total building area on the 129-acre plot amounts to 27.4 per cent.

R. H. Shreve is chairman of the Metropolitan Board of Design, and Starrett Bros. & Eken Inc., is the general contractor.

Contractor Paid For Legal Delay

Court holds contractor need not know condition of federal fund from which he is paid

A construction firm holding a contract with the federal government is not required to ascertain the condition of the appropriation account from which he is to be paid, according to a decision of the U. S. Court of Claims. The decision was rendered in Washington, D. C. in the case of Joplin & Eldon, Oregon contractors, who sued to recover $38,000 from the National Park Service because of losses incurred in an eight-months tie-up due to lack of funds for a road project in Mt. Ranier National Park.

The firm was awarded a contract by the park service in July, 1926, to build a highway which was to be finished by July 1, 1928. An appropriation was authorized for the project, with provision for a 25 per cent increase if there were changes in the plan. Changes were made, the road being widened, and the completion date was advanced to Jan. 1, 1929.

By October, 1928, the firm had finished work amounting to $238,000 and was expecting to finish by the deadline, when the park service advised that funds had been exhausted and the contractor could either finish under his own financing or close down. The latter course was chosen, and the firm was not authorized to proceed again until June 21, 1929.

The firm sued for $38,000, the point at issue being whether the notice by the park service to the contractors to suspend work constituted a breach of contract.

• • •

Hogan Leaves Fair For Private Practice

J. P. Hogan, who has served as chief engineer of the New York World's Fair since the start of construction, has given up that position to return to private practice as a member of the engineering firm of Parsons, Klapp, Brinckerhoff & Douglas. Hogan will continue as a vice-president of the Fair corporation and as its chief engineer consultant.

In announcing Hogan's retirement from active work at the Fair, Grover Whalen, president of the Corporation said: "The engineering and construction incident to the building of the New York World's Fair was one of great importance and the success achieved by the engineering department, headed by Colonel Hogan, will be recorded in the engineering records as one of the greatest engineering accomplishments of modern times."

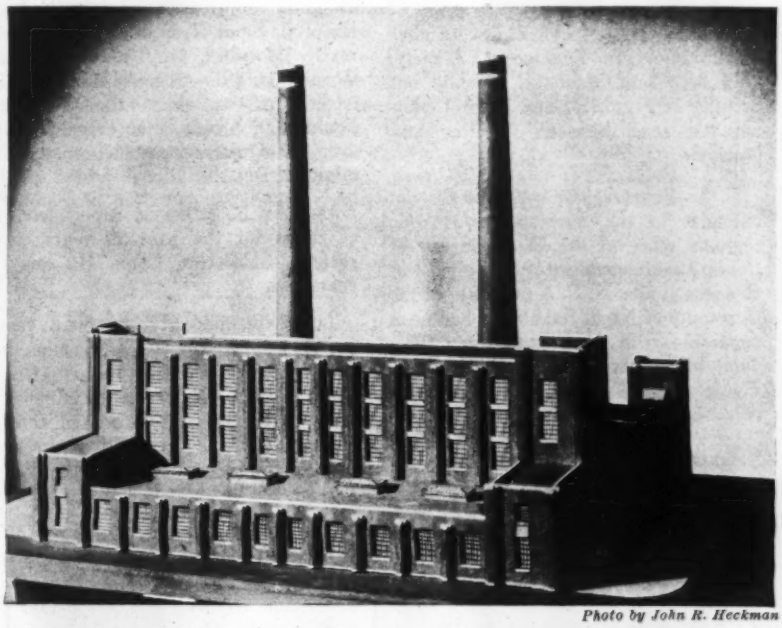


Photo by John R. Heckman

MODEL OF PITTSBURGH INCINERATOR

CONTRACTS have been let for construction of an incinerator for the city of Pittsburgh, a model of which is shown above. Located near the Allegheny River the project will cost $1,050,000. Shown is the 200-ft. flank of the building with the two 10-ft. diameter chimneys which will vent the furnace fires 200 ft. above ground. The structure will have a capacity of 600 tons a day.

Check on Labor Saving Gets Nowhere

Numerous bills to limit labor-saving machinery are all held up in committee

A number of resolutions introduced during this session of Congress with the object of investigating or limiting the introduction of labor-saving machinery have been held in committee without action. One of the first measures introduced at this session was S. J. Res. 3 authorizing the secretary of the treasury to investigate "the desirability and practicability of the imposition of a tax on the use of labor saving and labor displacing machinery." Despite the fact the resolution was introduced by Senator Clark, a member of the Finance Committee, the committee has taken no action on the bill. An identical resolution was introduced in the House by Representative Cochrane.

Study unemployment

A House joint resolution by Representative Faddis proposes an investigation of the "displacement of labor by machinery," which would be made by a committee on technological unemployment to be appointed by the president, consisting of respresentatives of the AFL, CIO, the departments of labor and commerce, and the Chamber of Commerce. This resolution has been before the House committee on labor since March 28 without action being taken.

A joint resolution introduced in April by Representative Wood would have Congress set up a division of labor productivity in the Bureau of Labor Statistics. It would be the duty ot the division to make continuing studies of productivity and labor costs in various industries. No consideration has been given this bill by the labor committee.

• • •

Building Costs Found Below Long-Term Level

Industrial building costs in the first half of 1939 were 8 per cent below the 25-year average for such work, according to figures compiled by the Austin Co., engineers and builders of Cleveland. The current cost is $1.40 per square foot for one-story daylight plant construction as compared to a 25-year average of $1.52. The record high is $2.67 as of the spring of 1921 and the low is $1.08 recorded during the first half of 1933. These costs do not include heating, lighting and plumbing.

OBITUARY

JOSEPH A. MCINERNEY, 47, president of the building and construction trades department of the American Federation of Labor and former president of the New York Building Trades Council, died July 10 at New York.

CALVIN L. BARTON, 64, consulting engineer of Norwalk, Conn., died May 10. After graduating from Cornell University in 1899, he joined the Rochester Bridge & Iron Works and later the American Bridge Co. Barton was soon employed by S. Pearson & Son in construction work on the North River tunnels for the Pennsylvania R.R. and later he acted as general superintendent for the Phoenix Construction Co. In 1906 he and Leslie McHarg formed the McHarg-Barton Co. In 1928 Barton acted as engineer for the Fraser Brace Co. on the Fifteen Mile Dam on the Connecticut River.

WALTER M. DAVIS, 70, engineer employed more than 20 years by the waterworks department at Elyria, O., died July 7 in Cleveland.

DIX E. WASHINGTON, 72, for 30 years consulting engineer in the building of large industrial plants in Europe, Asia, and the United States, died July 3 at Raymore, Mo.

DANIEL Y. DIMON, SR., civil engineer, died July 8 at Long Island, N. Y. He was a graduate of the school of engineering of Cornell University in 1896 and started his career with the Groton Bridge Co., later joining the J. G. White Engineering Co. During the War he served as engineer in charge of design and construction in a Staten Island shipbuilding concern. Later he was associated with Foster-Wheeler Corp., the George A. Fuller Construction Co., and Gibbs & Hill. For the past 18 months he had been with the New York City Board of Water Supply. His age was 65.

N. M. HANSEN, project engineer for WPA in Utah, died July 6. He graduated from Utah State Agricultural College and later attended Harvard University. He then engaged in engineering work in the Feather River canyon and for a time was city engineer for Logan. Later he was employed in the state engineer's office, and for the past two years was project director for WPA.

A. BRONSON CARPENTER, 48, recently retired associate highway engineer of the U. S. Bureau of Public Roads, died July 7 at South Westerlo, N. Y. He was educated at Cornell, Columbia and Brooklyn Polytechnic, and had been associated with the New York state highway department, the Westchester Park Commission, and the Bureau of Public Roads until the winter of 1938-39, when he retired because of poor health.

FRANCIS H. MILLER, president and co-founder of the Hoosier Engineering Co., of Columbus, died July 4. After graduating from Purdue University, he joined the Indianapolis Power & Light Co., which he left in 1919 to go into contracting. During the war he served as major in the 113th Engineers.

MAJ. FRANCIS J. FITZPATRICK, 55, executive officer of the Pittsburgh district of Army Engineers, was killed July 15 in an auto accident. He began his engineering work as instrument man with the Indiana Harbor Ry. Co. and in 1906 worked as topographer with the Cananea, Yaqui River & Pacific Ry. Later he was employed by various railways including the Chicago, Milwaukee & St. Paul, Northwestern Elevated, North Coast, and the Oregon-Washington Railroad & Navigation Co. In 1911 he became associated with the Isthmian Canal Commission.

CARL ILLSTRUP, retired assistant city engineer of Minneapolis, died June 28 at the age of 78. He had done important work in developing the Minneapolis sewer system.

WILLIAM VINCENT, 95, oldest member of the Michigan Engineering Society, died July 7 in Manistee. He laid out the city of Frankfort and in 1871 plotted the road between Cadillac and Manistee.

L. T. POWERS, 45, assistant district engineer in the Spartanburg, N. C., regional office of the U. S. Bureau of Public Roads, dropped dead July 12 at Hendersonville, N. C. A graduate of the University of North Dakota, he had been connected with the bureau since 1933, going to Spartanburg from Washington. For a time he served in the bureau's office in Jefferson City, Mo.,

WARREN A. TYRRELL, 64, designing engineer for the board of water supply of New York City for the last 11 years, died June 29. He was a graduate of the civil engineering department of Washington University, St. Louis, in 1897. In 1899 he joined the St. Louis water department, leaving there in 1901 to become engineer for the Christopher and Simpson Architectural Iron & Foundry Co. In 1917 he had charge of extensive construction work at Annapolis. After the World War he was with the J. G. White Engineering Corp. in New York for several years and later was production manager for the Chromium Corporation of America and had an active part in the widespread introduction of chromium plating.

HENRY T. STEELE, Seattle bridge construction engineer, died in that city July 10. He was 57 and had been employed by the Great Northern R. R. for more than 20 years.

MALCOLM MACDONALD, 59, well known construction engineer, died at Brooklyn, N. Y., July 13. A native of Scotland, before coming to the United States he worked on construction in Scotland, England, and South Africa. Coming to the United States shortly after the World War he was engaged in dredging operations on the New York barge canal. In the last five years he had been connected with the WPA in Brooklyn, where he had charge of sewer construction.

HENRY S. BIRKMEYER, 72, chief engineer of the Galveston, Tex., municipal waterworks, died July 7. He had been with the city for 38 years.

HERBERT G. CRISP, 73, one of the leading architects of Baltimore, died July 12. In the architectural field in Baltimore for more than 55 years, he had planned and supervised the erection of many buildings there, including the Calvert Building, the Title Guarantee and Trust Co., the Emerson Hotel, and the Provident Savings Bank. He also designed buildings for Johns Hopkins Hospital, Sinai Hospital, the New University Hospital, the Union Memorial Hospital, and Bon Secours Hospital. His latest project was the Nemours Foundation hospital for crippled children, now under construction at Wilmington, Del.

ELMORE E. SKINNER, superintendent of roads for the past 39 years, died recently at Berlin, Conn. He was 74 years old.

JASON W. NEMOYER, for ten years engineer in charge of construction for Greeley & Hansen, died June 26. Graduated from the University of Illinois in civil engineering in 1921 he had worked continuously since graduation with that firm except for service during the World War.

LOUIS P. GASTON, civil engineer, died July 14 at the age of 74. After graduating from Lehigh University in 1889 he became connected with the Cofrode & Evans Co. He had worked for the Norfolk & Western Ry., the New York Susquehanna & Western R. R., and for the Raritan Water Power Co. In 1901 he formed the contracting firm of Richards & Gaston and in 1910 became its president. He retired from the firm in 1925.

Buffalo City Hall Defects Covered in Report

A report on the nature and extent of defects in the $7,000,000 city hall at Buffalo, N. Y., completed in 1931, has just been made public by Commissioner of Public Works, Louis A. Harding. The report was drawn up last fall and turned over to Special Prosecutor Frank G. Raichle who said there was no possibility of criminal prosecution because more than five years had elapsed since the building was completed and accepted by the city.

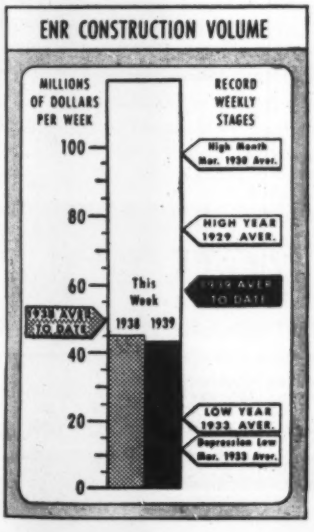
Commissioner Harding's report asserts that the defects became noticeable in the bulging of certain exterior walls. He alleged this was due to failure "to insert proper anchors so as to tie together the brick work and exterior stone work of the building." The demolition and reconstruction of two stone walls adjacent to the basement ramp and the granite walls surrounding a statue also are referred to in the report. The city plans to spend $30,000 on the building's reconstruction during the next fiscal year. This fiscal year's budget for the City Hall repair work amounts to about $5,000.

CONTRACTS AND CAPITAL

LOWER public construction volume this week brings the engineering construction total down to $43,783,000 as reported by *Engineering News-Record*, compared with $58,003,000 last week and $45,035,000 a year ago. Public awards at $29,115,000 compare with $40,876,000 last week and $35,692,000 last year. Federal awards are off most $1,875,000 this week compared with $7,811,000 last week and $9,594,000 last year.

Private engineering construction at $14,668,000 is below last week, $17,127,000 but higher than last year $9,343,000.

Classes of construction which show a gain this week over last include waterworks, commercial building and unclassified. Classified subtotals for the week are: waterworks, $1,985,000; sewerage, $2,237,000; bridges, $1,545,000; industrial buildings, $2,883,000; commercial buildings, $9,755,000; public buildings, $6,045,000; earthwork, drainage, $837,000; unclassified, $4,159,000.



State and municipal bond sales set a new record for the year of $39,280,000 which includes $35,000,000 for the city of New York. Federal appropriations bring the total for the week up to $96,230,000. No relief act funds have been included in new capital to date. The cumulative total for the year to date is $1,750,093,000 compared with $2,378,536,000 last year.

CONTRACTS

(Thousands of dollars)

	Week Ending July 21 1938	July 13 1939	July 20 1939
Federal	$9,594	$7,811	$1,875
State & Municipal	26,098	33,065	27,240
Total public...	$35,692	$40,876	$29,115
Total private..	9,343	17,127	14,668
TOTALS	$45,035	$58,003	$43,783
Cumulative 1939 .....(29 weeks)....			$1,696,559
1938 .....(29 weeks)....			$1,429,548

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 29 Wk.	1939 29 Wk.
NON-FEDERAL	$1,244,685	$928,566
Corporate securities	191,938	134,355
State & Mun. bonds	371,264	370,641
R.E.A. loans	11,629	83,732
R.F.C. loans	64,891	3,419
P.W.A. allotments.	292,393	.....
U.S.H.A. loans	111,070	146,419
Federal Aid—Highway	201,500	190,000
FEDERAL	1,133,851	821,527
TOTAL CAPITAL...	$2,378,536	$1,750,093

FHA MORTGAGES

	Week Ending July 16 1938	July 8 1939	July 15 1939
Selected for appraisal ...	$23,854	$15,328	$22,300*
Cumulative 1939 .....(28 weeks)....			$638,970*
1938 .....(29 weeks)....			$509,955

*Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	July....	234.94	112.94
Building Cost	June....	235.02	112.97
Volume	June....	193	84

Both Sides Firm In WPA Strike

(Continued from p. 35)

AFL leads strike

In contrast to previous WPA strikes, which have usually been led by the more militant Workers Alliance, the main leadership of the present demonstration is coming from the American Federation of Labor. President Green of AFL denies, however, that the strike was ordered by the national leadership, saying it is a spontaneous demonstration on the part of local bodies. "We fully recognize," he said, "the fact that the remedy lies with Congress, rather than through strikes on WPA projects."

Green has proposed to President Roosevelt a possible compromise under which the law as it stands would be interpreted to apply only to WPA projects started after July 1, when the law went into effect; prevailing wages would continue to be paid on projects started before July 1. The President has given no indication of his reaction to this proposal.

Non-WPA projects affected

An important move to broaden the strike came this week in Philadelphia, where the Building Trades Council ordered a strike, to become effective July 19, on all building construction projects in the city "financed in part or whole by the federal government." The strike would affect several federal buildings as well as PWA projects and federal housing projects.

No reliable estimates of the number of men on strike or of the number dismissed from WPA for striking are available. The last official announcement by WPA, on July 12, estimated the number of strikers at about 100,000.

• • •

Missouri May Not Charge For Wires Along Roads

The Missouri state highway commission does not have the right to charge rental for wire lines placed along Missouri highways or across bridges was the decision handed down by the circuit court at Clayton, July 10, in a $1,600 suit filed against the Union Electric Co. The court ruled that the state commission may control the placing of power lines and wires along highways or on bridges but does not have the right to charge rentals.

In 1931 the highway commission took over a bridge across the Missouri River at St. Charles. At that time Union Electric had a contract with the private owners that called for payment of $800 a year rental

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Flood Control Policy

Sir: I want to commend your editorial on flood control in your issue of May 25, p. 700. It seems to me that it is exceedingly unfortunate that the flood control policy of the country seems to be drifting into a policy of the federal government assuming the entire responsibility for the construction of all types of flood control and assuming the full obligations of the administration, operation and maintenance of these works after they are built. This is being done regardless of how local the nature of the project may be.

It seems to me that this matter is one of primary national importance. I am not convinced that it is wise as a general policy to eliminate entirely local financial responsibilities in such projects where there are definite local benefits. When there is a local share in the cost there is a check on unwise spending for unjustified projects. Regardless of the diligence of members of the Senate and the House, that added check is needed.

It is true that the 1938 flood control act seems to adopt a national policy for full payment and the administration by the federal government of flood control projects. However, there is urgent need for delay in allowing this policy to be applied to specific projects until there is an opportunity for changes and improvements in that policy. We need a stable, well thought out federal flood-control policy. Also we need a more thorough study of the problems of flood control for our larger rivers before we go too far with the construction of some of the proposed works. Otherwise, there will be disappointments if we depend only upon present proposals.

During the past few years the subject of flood control has been brought very much to the attention of the public and writings on this subject have been published in all kinds of publications including much publicity in the newspapers. Some of these writings have been such as to give the general public an exaggerated impression as to the benefits that the public may expect from the construction of certain proposed flood control works. With these exaggerated ideas public support has been secured for projects with questionable merit. Perhaps in some cases that public support would not be so prompt if the public were truly informed as to the benefits to be expected. While perhaps we cannot place particular blame on newspapers and other publications, I think the engineering profession and engineering publications should be especially diligent to do all they can to see that the public is given the true facts as far as they are available. It is time now that flood control propaganda be replaced by sound engineering and economic facts.

C. C. CHAMBERS
Chief Engineer,
Muskigum Watershed Conservancy District
New Philadelphia, Ohio

PWA on Pier 99, New York City

In the article "Pier Deck Lowered in One Piece Using Large Threaded Hangers" published in *ENR* July 6, 1939, p. 65, credit to the Public Works Administration was inadvertently omitted. This is a PWA project, and M. J. Patterson is resident engineer for PWA. The name of William Cristofferson, inspector for the New York Department of Docks, should also have been included.

Formula for Arc Length

Sir: In the April 13 issue of Engineering News-Record, p. 512, there appears an article entitled "Length of Parabolic Arc" by E. I. Fiesenheiser and F. J. Sauer of the U. S. Bureau of Public Roads, St. Paul, Minnesota.

The formulas therein stated are exact for the length of a parabolic arc and, where absolute accuracy is required, should be used. While these formulas are not involved, a formula known as the "Approximate Formula for the Length of a Parabolic Arc" is more simple in form and gives remarkably accurate results where the ratio of k to L is not excessive. Using the same nomenclature as in the article cited, the formula is stated thus:

$$s = L + \frac{2k^2}{3L}$$

Engineers working with cable spans and parabolic arc design generally find this formula of sufficient accuracy to meet the requirements of their design. Where greater accuracy is required and the exact parabolic formula is used, the approximate formula is recommended as a very rapid check calculation.

For purpose of illustration and comparison, calculations have been made both by the exact approximate formulas for length of arc using a value of $L = 2{,}000$ ft. and values of k ranging from $k = 50$ ft. to $k = 400$ ft. as tabulated below.

For the convenience of engineers working with cable spans and parabolic arches the formulas may be written in the more familiar form changing nomenclature as follows:

L = Horizontal length of *full span* arch or cable.

k = Dip or rise at center.

s = Arc length corresponding to span length L.

The exact formula for length of arc then becomes

$$s = \tfrac{1}{2}\sqrt{L^2 + 16k^2} + \tfrac{1}{8}\frac{L^2}{k}\log_n\left(\frac{\sqrt{L^2 + 16k^2} + 4k}{L}\right)$$

Note: $\log_n$ = Naperian or natural logarithms.

For conversion to base 10 logarithms $\log_n = 2.302585 \log_{10}$.

For use with logarithms to base 10, formula becomes

$$s = \tfrac{1}{2}\sqrt{L^2 + 16k^2} + .287823\frac{L^2}{k}\log_{10}\left(\frac{\sqrt{L^2 + 16k^2} + 4k}{L}\right)$$

The approximate formula for the

Horizontal Ordinate L Ft.	Vertical Ordinate k Ft.	Length of Arc Exact Formula Ft.	Length of Arc Approx. Formula Ft.	Variation Ft.
2000.00	50.00	2000.855	2000.833	—.022
2000.00	100.00	2003.350	2003.333	—.017
2000.00	150.00	2007.475	2007.500	+.025
2000.00	200.00	2013.249	2013.333	+.084
2000.40	300.00	2029.534	2030.000	+.466
2000.00	400.00	2052.12	2053.33	+1.210

length of a parabola becomes

$$s = L - \frac{8k^2}{3L}$$

The approximate formula is derived by setting up the differential expression of the curve in an infinite series and integrating the first two terms of same. As a matter of academic interest, especially to those dealing with cable spans, the same approximate formula above is obtained from the expansion of the catenary equation in a series.

PAUL E. MAGERSTADT
Timber Engineering Co. of California
San Francisco, Calif.

Impressions of the Waterworks Convention

Sir: It was fine to see the good old Atlantic Ocean—it's the one thing in this U. S. A. which seems to keep on an even keel. Steady and sure and substantial, it is to be depended upon to continue indefinitely the same way, operating under the rules and regulations established for oceans even before our forebears wrote what they thought was going to be a permanent constitution. But anyway, there it was—calm and powerful and reliable that Tuesday morning as the sun just began to peep over the horizon as we walked along the Boardwalk trying to find our hotel, at which we had arrived late the night before for the A.W.W.A. convention.

At nine that morning when the telephone awakened me, I was not in sympathy with the judgment of the program makers of the convention, who set the first paper at 9:30. It wasn't possible to get to the first lecture that morning, but I did get to the Auditorium just in time to be on deck for the quarrel between two speakers, both on the program and both of great importance, over which one should speak first. The Governor of New Jersey had upset the apple cart by coming into the hall, accompanied by the civil and military of the state, at the wrong time. I liked Gov. Moore's speech, his nice Irish face and Irish brogue and his stories—but I had always thought that Allen Hazen and W. T. Sedgwick were the boys who did most toward the elimination of typhoid fever from drinking water.

The quarrelers didn't come to blows, although one of them is known to be a little pugnacious and the chairman stepped into the breach in his usually skillful way; he has chairmaned such meetings before, and all proceeded in an orderly way. That morning the technical papers, to my perhaps slightly foggy mind, were notable most for that which the speakers left unsaid.

After that we strolled through the exhibition hall and were much impressed. The representatives sent to these conventions by the manufacturers are an unusually good looking crowd and my impression was that they are far better paid than the rest of us, they dress so well and look so well fed and spick and span—by noon. But why do they decorate all their exhibits with the prettiest girls and best dancers among the conventioneers, or are they all registered? We were interested enough in some of the exhibits to have entered the spider's web even if there had been no pretty bait there. But that's not a technical matter—that probably has to do with business—just another objectionable thing about business. We will have to suggest that the Secretary of the Interior look into the matter.

That night the All Sections Dinner was grand. As I remember it, there was a big crowd, on the edge of which we sat because we were a little late somehow. What did they do with that Old Oaken Bucket? What do they use for drinking water at Atlantic City anyway? Did anyone see enough to fill that bucket?

The next day was Wednesday, June 14th, the anniversary of our wedding—a beautiful day which we enjoyed exceedingly. Our children and grandchildren all remembered it and sent us telegrams and some of our friends at the convention sent the "Missus" flowers and gave us a very delightful dinner party on one of the back streets, which made us late again, this time to the Monte Carlo party. That was alright, but the next day I found from the program that it was still June 14th. You don't know how funny that made me feel. I've seen double at times, but of all the things to have double up on one at my age one's wedding anniversary is the craziest. I asked one of the men sitting near me if he saw what I saw on the program and he said he did. Just another blunder by the program makers.

I forgot to say that Tuesday afternoon I didn't feel like hearing about any kind of hammer. My head still ached, so I let others attend the water-hammer symposium.

But service lines is another matter and I got there bright and early one of the two June 14ths to hear the papers on that or those subjects. The crowd attending these early morning meetings was impressive—in numbers and condition. We had always just used service lines—any old kind we could find to carry water into our consumers' houses—and I was impressed with the number of different kinds that can be used and should not be. There are good and bad service line materials (I pitied the poor fellows downstairs who had paid good money for space in the exhibit hall to show their bad kind). There are even poisonous service lines and we have the word of the supreme court of Massachusetts to prove it—and in Massachusetts, the supreme court is the SUPREME court.

They got way over my depth and the undertow was too strong for me at the session Thursday morning. Still the 14th. "Correlation between the Carbon Dioxide and Mineral Content of water and its corrosivity" doesn't sound so bad although it's bad enough, but when the diagrams came on the screen and one had to remember back to previous slides to understand why the abscissas and ordinates had been reversed in this one and if not why not, several of the audience woke up suddenly and left the room. Then this question of super-chlorination—why, even Governor Moore of New Jersey only used ordinary chlorination and I'll bet he never heard of this super stuff. Anyway a lot of the crowd stayed through it with me—and we were well repaid when one speaker from Boston said it was silly to waste all this time in discussing such refinements in purification of the water at the source if down in the city one left open the valves on the cross-connections between the water and sewer systems.

And the next day after the dinner dance of the night before, we left and came home to sleep in bed.

FARLEY GANNETT
Harrisburg, Pa.

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JULY 20, 1939

FIRST BASIC REFORM in the work-relief system, the extension of WPA working time to 30 hr. a week promptly confirmed the prevalent belief that the system is utterly unsound. Stoppage of work by thousands of WPA men gave an amazing revelation of the fact that they object to working for their relief payments but insist on being supported by the community in return for part-time work. If the strikers would rather get along without their WPA income than perform a decent month's work, probably many or most of them could get along well enough on their own—which supports the opinion of those who have long held that the WPA rolls are heavily padded. The situation also confirms the wisdom of Congress in requiring a layoff after 18 months' continuous employment. With the layoff and working time reform and with restriction of WPA construction to projects of moderate size the system is due for a transformation badly needed after four years of disorganizing influence on both industry and the unemployed worker.

A Notable Superhighway

OUTSIDE OF METROPOLITAN AREAS few states have developed limited-service high-speed roads on the ambitious plan of the Merritt Parkway in Connecticut. As described on a following page the four-lane divided highway, even with its remarkable structures and dimensions, is only half of the planned road, for a twin road may later be constructed on the unoccupied half of the 300-ft. right-of-way. But aside from its unusual elements the Merritt Parkway has interest as a study in cross-section design. Is the double-curb travelway with 13-ft. lanes but without usable shoulders as advanced a design as its originators five years ago thought it to be? Present practice leans to a pavement 3 ft. narrower, no outside curbs and flush shoulders wide enough for parking lanes; recent four-lane divided highways in Connecticut are of this revised cross-section. Regardless of such newer thinking, however, the Merritt Parkway stands as the most advanced passenger highway yet built.

Labor at Its Worst

FOR SHEER STUPIDITY and irresponsibility organized labor has seldom appeared worse than at New York last week, when Local 147, comprising the sandhogs of the Hod Carriers International Union, violated its agreement with the contractor by striking and shutting down the Queens Midtown Tunnel job, and invaded the Delaware Aqueduct tunnel work north of the city to upset agreements made by contractors there with Local 60 of the same international union. Naturally, the aqueduct tunnels were disrupted while Local 60 workers left their jobs to fight off the invaders. Contractors on more than a hundred million dollars worth of tunnels were innocent victims of a wholly inexcusable inter-union squabble. In this dispute so far the international union officials have been powerless, further indication of the lack of responsibility in labor ranks. Even more disturbing, however, is the fact that the elaborate labor relations system we have set up in this country did not function here. No labor board or department appears to have made any effort to stop the warfare. It is time we devised some labor-relations machinery that will really promote industrial peace.

Unsolved

EXPANSION BEARINGS have a well-deserved reputation for being one of the most troublesome details with which the bridge engineer has to cope. Whether designed to slide, rock or roll, they too often develop defects which render them ineffective. The recently reported life history of the bearings under the Manchester Bridge in Pittsburgh is typical. Installed over thirty years ago, neglected for fifteen years, found to be defective in operation, extensively repaired, neglected again, then more or less continuously subjected to repair, the bearings have now been replaced by completely new bearings of improved design. In the Manchester Bridge the design of the original rockers fostered failure; perhaps modern rockers avoid this defect. But one item in the above history has not changed in thirty years and that is inadequate maintenance. "Neglected for fifteen years" or ten or five years, is more often than not an appropriate epitaph for dead bridge bearings. Bridge engineers are solving the troublesome problem of bridge deck expansion joints by eliminating them entirely.

Such a simple solution not being possible for the expansion shoes, better mechanical designs and enforced annual maintenance must be applied.

Tolls to the Fore

TOLL ROADS have become a live issue overnight, with establishment of tolls on the Merritt Parkway and active consideration of toll collection on the Westchester County parkways. Road planners and road users have a new problem before them, one that calls for serious thought.

Highway tolls are not a new phase of modern transportation. Toll bridges and tunnels have for a number of years levied tribute on highway traffic, and under quite special circumstances the South Penn highway introduced the toll principle into the field of direct road service. The Congressional suggestion of a nationwide network of toll superhighways kept the idea alive. But Connecticut's action represents the deliberate decision of legislature and governor after comparing parkway costs with state revenues, while the Westchester discussions are due to a staggering burden of county parkway debt and prospective further reconstruction expense. Temporarily or otherwise, the toll road is here.

One of the reasons is governmental extravagance, which, seizing on all possible revenues to maintain itself, is diverting hundreds of millions of annual road taxes to general expense. In spite of this diversion parkways are demanded, as proved by the heavy traffic they attract, and probably many more will be built in the early future. This demand, coupled with the lack of funds, constitutes the problem.

It is plain that if the road user wants special transportation facilities he should pay for them. Thomas H. MacDonald's ingenious proposal to pay for such roads out of land-value increments by excess condemnation does not affect this principle. These questions present themselves, then: Has the gas-tax system broken down as a method of levying road service charges? Has road money been used in proportion to road service; in other words has the money been prudently and profitably invested? And—coming down to tolls—have we reached the time when a more direct service charge should be considered for special types of road? These questions involve issues of immediate importance.

Certain fundamental principles control the answer. First, we must have an adequate transportation system, even if it calls for special-service roads. Second, our general road system must be and always remain free to all. And third, revenues for construction and operation of all types of road must be raised by equitable methods based on transportation cost. Any system of highway revenues must accord with these principles, and unless it does so the incipient road-toll movement of today is bound to come to an early end.

A Question of Fact

WHY is housebuilding inactive in the face of the huge housing deficit that has accumulated during ten years? Assistant Attorney-General Thurman Arnold in a statement before the Temporary National Economic Committee charges that high building costs are at fault, and on this premise builds up a sweeping indictment of the whole construction industry.

As Mr. Arnold gives no supporting details it is difficult to discuss his charge of high costs and bad practices. For that matter the whole statement is so general and vague that it might apply to almost any industry or activity. But when he undertakes to correlate low housebuilding activity with high construction prices we have a plain question of fact, and the facts are against him.

Building has always been active when prices and building costs were high, and sluggish or dormant when prices and costs were low. The big building boom of the early '20s set in when prices were sky high, and persisted despite continuing high prices; on the other hand when prices were low, as in 1912-13 and in the early '30s, housebuilding remained dead regardless of price.

The record shows plainly that when men seek new homes they pay little attention to price, while in uncertain times they are unwilling to venture on home buying and price inducements cannot change their attitude. A fair conclusion is that the present condition—with the real estate market dead and home buyers scarce—is due not to costs but to the citizen's unwillingness to risk a commitment.

Admittedly there are bad practices in the building field—as there are in manufacture, in retailing and even in law. There are price handicaps and labor handicaps; the latter are probably the more serious in their effects. Sincere, sensible steps to remove these handicaps and establish sound practices would be constructive. But a grand campaign of prosecution introduced with loud fanfare is more likely to be destructive, especially if its premises disagree with the facts.

FIG. 1. BEAUTY IS COMBINED WITH SUPERSERVICE TO TRAFFIC IN CONNECTICUT'S MERRITT PARKWAY.

The Merritt Parkway

Contents in Brief—Construction begun in 1934 will be completed in 1940. Extension to the Massachusetts line authorized. Structural details described and landscaping illustrated.

CONNECTICUT is now approaching completion of its famous Merritt Parkway. By next year, when the 1,826-ft. Housatonic River bridge now under construction is completed all of one of the twin divided roads of the parkway will be ready for traffic from the New York state line to the bridge, some 37 miles. This summer the final stretches of grading and paving are being done, and the bridge is being built. At the bridge Merritt Parkway will end and the Wilbur Cross Parkway, having express road and parkway characteristics but not restricted everywhere to automobile traffic, will carry on in a generally northeast direction to the Massachusetts line. The sketch map, Fig. 2, indicates the route, that for the Wilbur Cross Parkway being little more than directional except in parts.

What is the Merritt Parkway? This question is often asked, and quite reasonably, since the preliminary studies were begun at least a dozen years ago and final design plans were first put into execution at least five years ago. Incidentally, these plans have not been much changed in half a decade of construction and though described then (*ENR* March 14, 1935) few precise details have ever been presented except of the grade separation bridges (*ENR* Sept. 23, 1937).

Roadway structure

With work drawing to an end something more definite on this remarkable road is useful as a record.

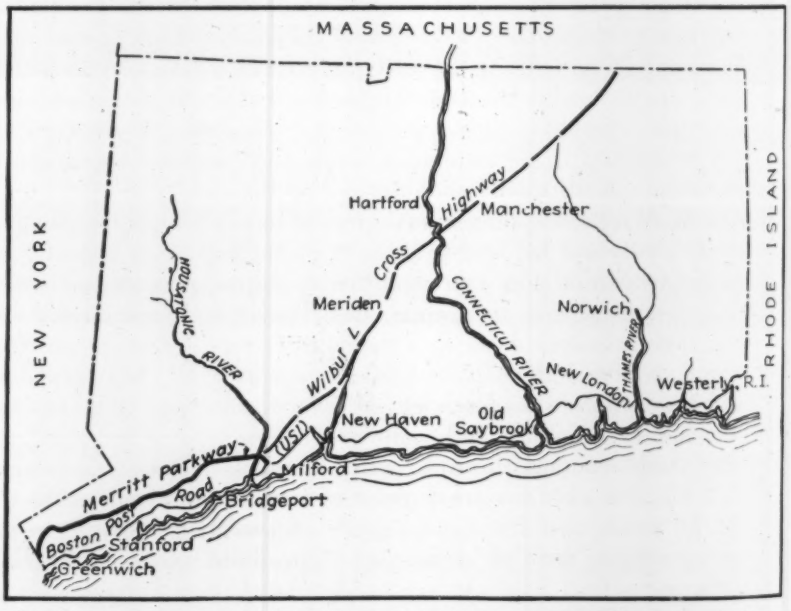


Fig. 2. Continued as the Wilbur L. Cross Highway the Merritt Parkway will give Connecticut a trans-state express road of superhighway standards.

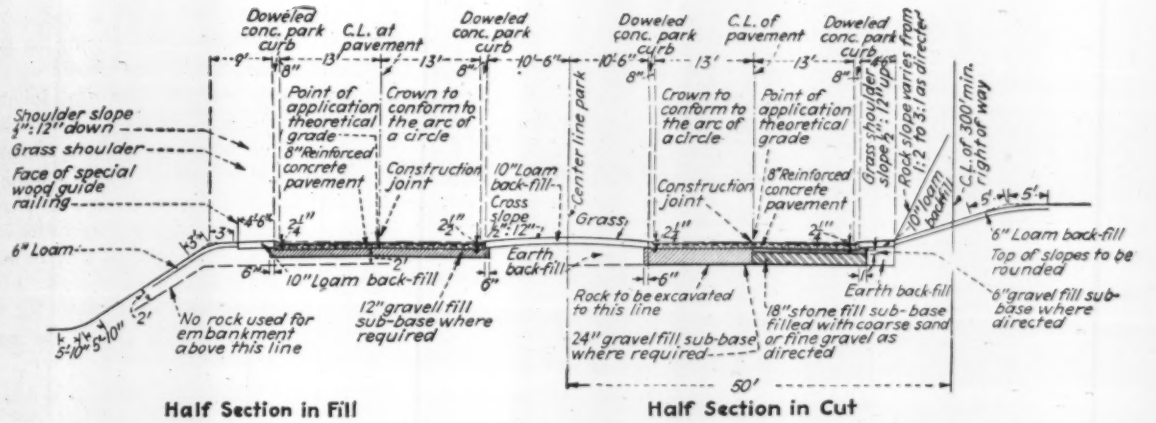

Doweled conc. park curb
C.L. at pavement
Doweled conc. park curb
Doweled conc. park curb
C.L. of pavement
Doweled conc. park curb
Shoulder slope ¼":12" down
Grass shoulder
Face of special wood guide railing
6" Loam
Point of application theoretical grade
8" Reinforced concrete pavement
Crown to conform to the arc of a circle
Construction Joint
10" Loam back-fill
Cross slope ½":12"
Center line park
Grass
Earth back-fill
10" Loam back-fill
12" gravel fill sub-base where required
No rock used for embankment above this line
Rock to be excavated to this line
24" gravel fill sub-base where required
Crown to conform to the arc of a circle
Construction Joint
Point of application theoretical grade
8" Reinforced concrete pavement
Grass shoulder slope ¼":12" up
Rock slope varies from 1:2 to 3:1 as directed
C.L. of 300' min. right of way
10" Loam back-fill
6" Loam back-fill
Top of slopes to be rounded
Earth back-fill
6" gravel fill sub-base where directed
18" stone fill sub-base filled with coarse sand or fine gravel as directed
50'
Half Section in Fill
Half Section in Cut

Fig. 3. Structural standards governing the Merritt Parkway are depicted by this typical cross-section; this road occupies half of the right-of-way; ultimate improvement calls for a similar road on the other half of the right-of-way.

In general, Merritt Parkway consists of twin four-lane divided highways on a right-of-way 300 ft. wide and on an entirely new route. Adjoining property has no entrance on the right-of-way but must use local roads to designated access points, generally at intersections where the grades are separated and where access is provided by ramps into the proper directional travel lanes. Only automobile travel is allowed. At the inception of the enterprise it was the intention that all traffic should have free use of the road, that the new road was to be a relief route for the overcrowded Boston Post Road, but as the project developed the idea of change to a high-speed scenic express road emerged, (why is not quite clear) and this idea grew. And now the road is an automobile road only, is elaborately landscaped, as the accompanying illustration shows, and recently has begun to collect a toll (10c. a car) from travelers from and to New York. The original general-service road idea of the early thirties has completely disappeared.

As stated, only one of the twin roads is being built, on one side of the middle of the 300-ft. right-of-way; this is a four-lane divided highway, as shown by Fig. 3, which gives the essential details of design and structure. In viewing the cross-section the noticeable features are the wide traffic lanes, the double curbs and the absence of usable shoulders. While the design shown is being carried out on all the parkway it is not agreed by all the highway department engineers that it represents the best divided highway practice; some of them question the need of lanes as wide as 13 ft. and particularly object to the outside curb and no shoulder space onto which cars can pull off in case of necessity. As an indication of the controlling thinking, the typical design for another recent parkway includes a central 21-ft. park and on each side a park curb, a 12-ft. passing lane, an 11-ft. travel lane and a flush 7-ft. 5-in. surface-treated gravel shoulder.

Referring again to the Merritt Parkway, most of the details of roadway structure except curbing and drainage are made clear by Fig. 3. The across-road dimensions are most particularly noticeable; it is not recalled that 26-ft. two-lane pavements have been built elsewhere in this country on what is essentially a cross-country road avoiding cities and metropolitan areas. Fig. 3 shows the standard dividing strip of 21 ft. between curbs. At grade separations at intersecting road (about 70 are built or planned, either over or underpasses) the method of carrying the center dividing strip over and under the several bridges has been subject to considerable variation. For the earlier structures, the lanes were converged by easy curves until the separating strip was reduced to a width of 16 in., the width of the concrete curb along the inside edge of the lanes.

Later development and special conditions have resulted in numerous departures from this original practice. Various widths of dividing strip have been used, from 16 in. up to the full 21 ft. In one case separate structures were built for each lane, separated by an open space surrounded by bridge railings. In other cases the area between lanes has been covered with open grid flooring, partly as a means of providing light to the road below and partly as a measure of safety to the parkway traffic.

At structures over the parkway where the width of dividing strip is not reduced, the present tendency is to employ 2-span structures with piers in the central grass plot. Another recent development has been to set the abutments back from the edge of the pavement and to provide a 4 to 5-ft. grassed area. This seems to add to the peace of mind of the driver and to remove a feeling of crowding, although the actual width of roadway available for his use is not quite as great as on the older designs.

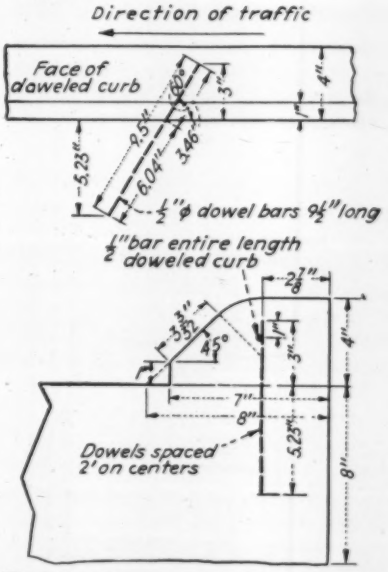


Fig. 4. Curbs are constructed separately after the slab is finished; sketch shows dowel arrangement.

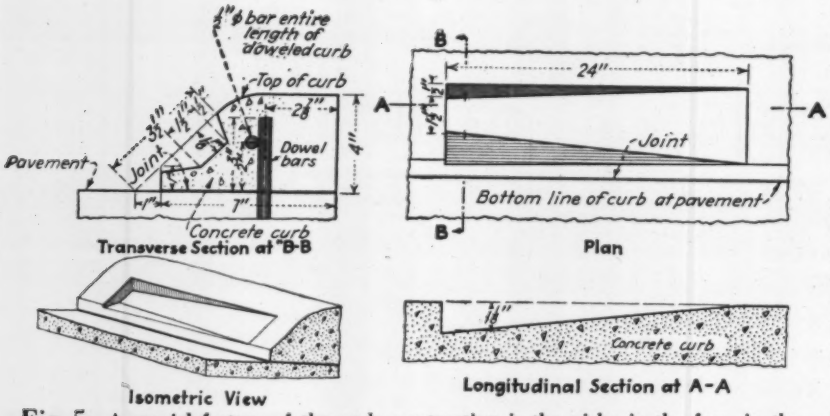


Fig. 5. A special feature of the curb construction is the niche in the face, in the shoulder of which is set a reflector button to indicate the curb line at night.

On the parkway each paved surface is crowned at the center and drains to both curbs and the park is crowned and drains to the inside curbs. The curb as shown by Fig. 4 is formed separately after the pavement slab is constructed, being bonded to the slab by dowels having a pitch forward in the direction of traffic. This clears the way for straightforward finishing machine operations on the slab. Outstanding in the curb design, however, is the niched face detailed in Fig. 5. A reflector button set in the niche, which is beveled in the direction of traffic, discloses the line of the curb clearly for night travel.

Surface drainage is all to the curbs along which the water travels to inlets and catchbasins from which pipe lines discharge at suitable points outside the roadway. Fig. 6 shows typical inlets on grade and at dips. All inlets, it will be noted, are in coves outside the travel lanes, the curbs being carried around the catchbasin grating.

Construction requirements

Connecticut, provided with the finest of concrete aggregates and long experience in good concrete road-building, has not had to go beyond its usual practices for the Merritt Parkway paving. The sound sub-base construction shown by Fig. 3 is essentially that of regular main road practice, the standard uniformly thick slab is used and each travel lane is separately constructed. All concrete is vibrated and for vibration the standard proportions are about 1 part cement, 2 parts fine aggregate and 4.3 parts coarse aggregate, with privilege of change at the engineer's direction to obtain satisfactory workability.

Special care is given to vibrating and finishing operations. All is machine work generally in the following sequence: With the concrete spread, it is struck off with a full-width transverse screed not resting on the side forms; vibration follows with a full-width screed; finishing follows with the screed bearing on the side forms; a second finishing follows with a longitudinal screed machine and finally the surface is belted and broomed. Any of these operations is repeated or continued as may be necessary to insure proper work. Incidentally, as the specification for vibrating machines is one of the most recent, it is interesting to quote:

> When finishing by vibrating method is required, each finishing machine shall be equipped with vibrators attached to a vibrating screed or roller so designed and constructed that the concrete for the full width of the pavement slab can be simultaneously vibrated. The vibrator shall have a vibrating frequency of not less than 3,500 pulsations per minute and designed to permit adjustment of the amplitude of the impulse. A vibrating unit shall be required for not over 7 ft. of lineal length of vibrating surface. When more than one vibrating unit is used on a given device, the vibrating units shall be synchronized so that the vibrating pulsations are of the same duration, in the same direction, and uniformly applied in a vertical plane which is parallel to the axis of the pavement.

One of the beautiful roads of the country, as shown by the accompanying view, the Merritt Parkway owes much to its landscaping which has been given major attention. The story of the work done goes into the details of landscape architecture that have no place here. Inevitably, maintenance as it departs from the ordinary operations on pavements and draining structures is largely a task of gardening. The only exception is snow and ice removal, and in this work the divided road presents problems that road engineering has not successfully solved.

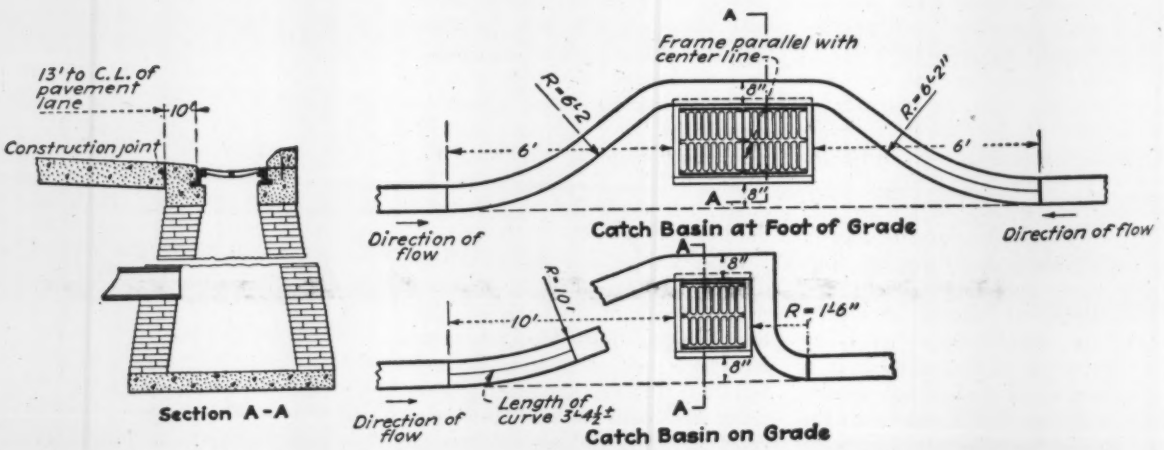


Fig. 6. All surface drainage is to the curbs where catchbasin inlets are set in coves clear of all vehicle travel.

A Brewery Waste Treatment Plant

Double stage trickling filter process adopted for high degree treatment in a Texas brewery

DEVELOPMENT of a satisfactory method for treatment of brewery waste and construction of a plant for this purpose has been undertaken by the Gulf Brewing Co. at Houston, Tex. The plant design, based on a year's experimental work, provides for the use of two trickling filters operated in series, along with primary clarification, sedimentation facilities between the two stages of filtration, and final sedimentation. Pilot plant results indicate that this process will give a 90 per cent reduction of B.O.D. and 75 per cent removal in suspended solids. Sludge will be digested and dried on sand beds.

The brewery plant has a capacity of 5 brews per 24-hr. day, each of 300 standard barrels of 31 gallons. Principal waste sources are drainage from spent grain and spent hops; washings from storage tanks and vats; skimmings and washings from fermenting vats; water used to wash filter cloths, returned bottles, and the outside of filled bottles; and scant waste from barreling. Laboratory tests of the brewery wastes gave the results shown in Table 1.

The waste discharges, averaging about 500,000 gal. a day, are emptied into Country Club Bayou, a 6-mile-long drainage canal. This waterway has a normal summer flow of 0.66 mgd but just before it passes the brewery it receives about 1 mgd of clean water from a cooling process at an industrial plant.

Experimental work

Under a Houston city ordinance, wastes dumped into the streams "shall be free from matter that will settle in the bottom of the channel, from all floating matter, and from any matter that can putrefy and cause offensive odors," it being required that waste shall have a methylene blue stability of 40 hours at 37 deg. C. Satisfaction of these conditions called for a relatively high degree of treatment.

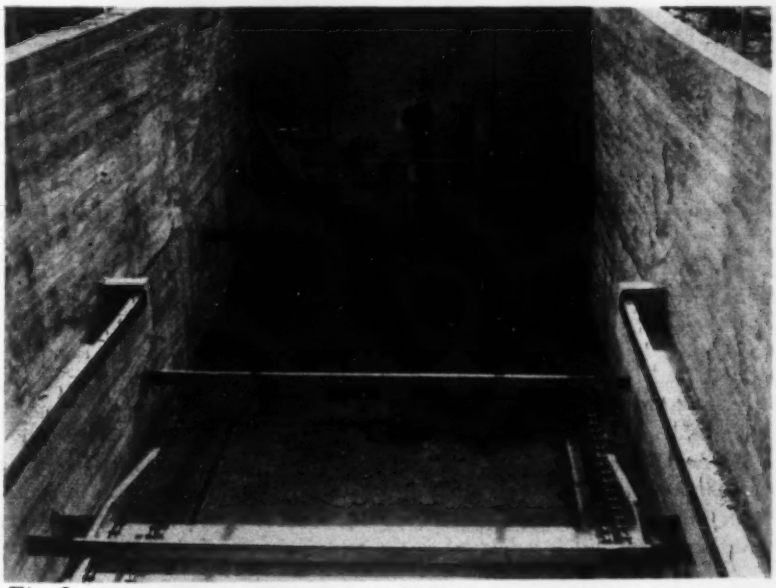


Fig. 2. Sludge collecting mechanism of the flight type in the final settling tank.

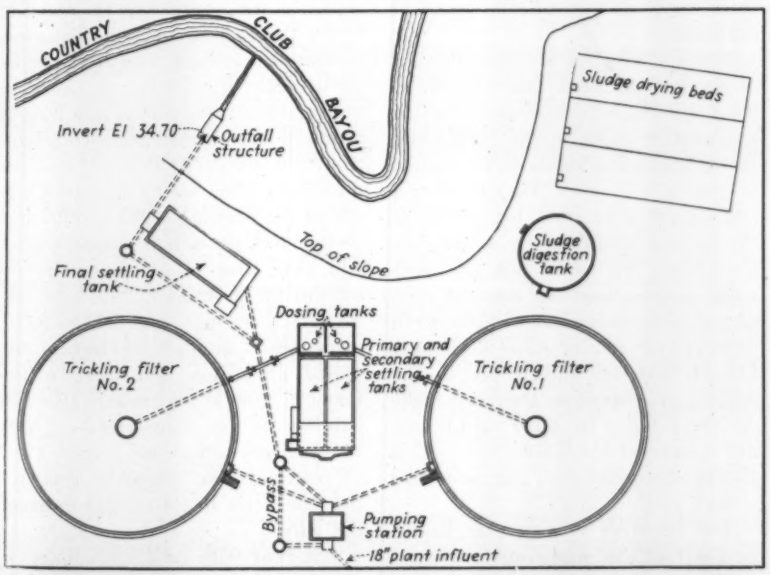


Fig. 1. Layout of the double-stage trickling filter plant for brewery waste treatment.

Chemical precipitation was tried experimentally in the laboratory but abandoned principally because of the large amount of sludge produced (from 2 to 2½ per cent of the flow) and the fact that this treatment reduced the B.O.D. only 70 per cent. This reduction was not sufficient to meet the limitations imposed by the low flow in the receiving stream.

Consideration was also given to partial chemical treatment followed by trickling filters. Laboratory tests on the daily influent samples showed excellent removals of B.O.D. (45 per cent) with stage flocculation using one-half pound of aluminum sulphate per 1,000 gal. However, it was felt that chemical treatment would be difficult to adapt to this waste which varies in strength and character from

minute to minute throughout the day and night.

The activated sludge process was not considered because of previous experience which indicated that the brewery wastes would cause sludge bulking. Furthermore, in a pilot plant built to test a contact aeration process the maximum average B.O.D. reduction for the period was only 45 per cent.

Studies on the two-stage trickling filter process showed that this would effect a reduction of B.O.D. (24-hr. basis) from 340 to 34 ppm, and the suspended solids could be reduced from 370 to 67 ppm.

Plant design

The plant includes two rectangular primary and secondary settling tanks with sludge collectors, each of which is 12 ft. x 42 ft. x 9 ft. deep. The tanks provide a detention period 1.5 hr. at average flow of 0.55 mgd. The final settling tank is 17 x 50 x 7 ft. deep. At average flow conditions it provides a detention period of 1.95 hours.

TABLE I—ANALYSIS OF THE BREWERY WASTES ON WHICH PLANT DESIGN WAS BASED

	Average	Average (Omitting Sat. and Sun.)	Maximum Day
Flow—M.G.D.	0.48	0.53	0.68
24 hr.—B.O.D.—ppm.	349	334	740*
24 hr.—B.O.D.—lbs./day	1,375	1,485	3,220*
Sus. Solids—ppm.	371	368	1,325
Sus. Solids—lbs./day	1,478	1,630	4,810

* One reading of 4002 ppm was thrown out as it did not check with other results for this day.

The primary and secondary trickling filters are 100 ft. in dia. and 6.5 ft. deep, and they are equipped with rotary distributors. Provision is made to operate either filter as a primary or secondary oxidation device and to operate both filters in parallel if desired.

The sludge digestion tank is 32 ft. in diameter and 18 ft. deep. No provision has been made for insulation or heating. The design is based on the storage of 1,650 lb. dry solids per day; the tank has a capacity of 14,500 cu.ft. The sludge drying beds cover an area of 2,080 sq.ft. and it is anticipated that they can be dosed 16 times a year.

The cost of the plant, excluding the preliminary engineering, will be about $60,000. It is estimated that operation will cost from $2,400 to $3,900 annually.

The plant is being constructed by the maintenance department of the Hughes Tool Co. of Houston. L. A. Godbold, plant engineer, is in charge of the work. Cooperation in the preliminary investigation and pilot plant operations was extended by S. L. Tolman, formerly manager, sanitary engineering division of the Jeffrey Manufacturing Co.

Why Not More Accurate Bid Plans?

Contents in Brief—A pipe manufacturer asks: Why don't engineering plans give the bidder for installed equipment the time or the information required for an adequate quantity survey? Because they do not, the lump-sum bid is a hazard to the material manufacturer.

As MANUFACTURERS of pressure pipe and fittings, the writer's firm applies for and receives many drawings on water-filtration and sewage-treatment plants. In most cases the drawings and specifications are not prepared sufficiently in advance to allow the necessary time to make a careful take-off of the material. In nine cases out of ten no attempt is made to check the take-off for two reasons:

1. Most engineers apparently know very little about the standard materials which pipe companies manufacture and the original layout is later very often changed considerably to take advantage of material for which the manufacturer has patterns.

2. Since the contractor cannot buy his pumps, valves, rate controllers, etc., until he has received the order for the job, it of course follows that the devices or materials he eventually purchases may differ considerably from those shown on the original drawings.

Now speaking for my firm: In view of the lack of time, and bearing in mind the numerous changes which are usually made in the layout, we do not attempt to figure exact lengths of piping for either flanged or bell and spigot pipe, and we arrive at the various quantities by scaling the blueprints. We admit that this isn't good practice but we are not concerned with theory but with the stern necessity of getting some kind of a bill of material and prices in the contractors' hands so they can make up their bids. In other words, we are confirmed clock watchers, which all the successful men tell us is bad—very bad.

The situation is also complicated by the fact that numerous engineers show a general layout on a scale of ⅛ in. to the foot and even smaller. It is obvious that quantities obtained by scaling a blueprint with this small scale are not very accurate. It would be desirable if time would permit the bidder to make a profile line drawing showing the connecting piping between the various units in water filtration and sewage treatment plants, particularly the latter, in order to arrive at the extra piping and fittings required due to differences in elevation; but ordinarily this is out of the question so that we have to cock one eye at the drawing and the other eye on the clock to see if the stenographer will have time to get the quotation out on the last mail, and with one masterful decision add 20 or 50 or some other number of feet to the scaled dimension and there is the take-off. This is very unscientific and careless to be sure—but we can't get business unless we submit a list of material with prices in time for the contractor to get his bid in under the wire.

But bear with us a little longer—

the story is only half told. Can you imagine the fun we have when some engineers send us a folio of photostat prints reduced from the original ¼ in. to the foot scale to some scale between $\frac{1}{32}$ in. and $\frac{1}{16}$ in. to the foot. There, my friends, you have something to worry about. Of course, photostat prints are cheap and they make a neat appearance, all bound up with a nice title sheet bearing the name of the mayor and the city council and the engineer's coat-of-arms —very, very pretty, but try to arrive at the quantities and sizes. Some one, of course, will promptly advance the idea of making up a scale from the photostat, which is a grand idea for one particular sheet, but when an attempt is made to trace a certain line through several different units (each of which has a different reduced scale) it makes for more fun.

Descriptions not definite

Some engineers, and we can include the larger and well-known concerns, are very careless in labeling the various kinds of pipe which may include cast-iron pressure pipe, steel pipe, wrought-iron pipe, vitrified-clay pipe, cast-iron soil pipe, etc. This may seem strange but we have worried away many valuable minutes with the clock ticking off their passing, trying to decide whether we should take a chance and show so many feet of cast-iron pressure pipe for a drainage line or whether we may assume that part of it is clay pipe and forget about it. In one case the lump sum price will be high and in the other we get stuck for some material which we find on page 38-A of the specifications should be cast-iron pressure pipe.

But to go on: In their haste to get out some kind of a drawing, the engineers fail to review or check their drawings to see whether the plan view checks with the elevations or sections or whether sheet 1 checks with sheet 10 in regard to the size of pipe lines. Believe it or not, we do some tall and fancy guessing on pipe size; and it happens frequently. What do you suppose happens when we assume too large a pipe size? Well, in this case our lump sum is high; if, on the contrary, we assume too small a size, we have to absorb the difference in price.

Some contractors are willing to pay the material manufacturer for the extra cost of cutting bell and spigot pipe to suit, and others prefer to buy standard lengths and cut to suit in the field. There are arguments in favor of both practices but since we have to send the same quotations to all contractors you have a good idea of our predicament. Here, again, in one case, we are high, and in the other case we have to furnish odd-length cuts at the same price as standard-length pipe. Does it run into money? Yes, it may affect the total price 2 or 4 per cent. Why not specify the method?

Piping through walls

Some engineers are not careful to specify the kind of construction permitted where pipe passes through concrete. Some allow the contractor to "box out" and then grout when the pipe lines are completed; some insist on a flexible connection, and by that is meant a calked lead joint on both sides of the wall; some insist on a wall casting manufactured to the exact size of the wall; others will accept standard-length pipe sleeves, although they may be an inch or two longer than the thickness of the wall. These fittings run into money: Shall we figure them and run the chance of losing the job? Shall we assume that the engineer will allow the pipe lines to run through the wall? Again the difference is enough to swing the job one way or the other.

We appreciate the advantage of a lump-sum figure to the engineer and to the contractor in evaluating bids. After all, he wants to know what the "dern" thing will cost without extending unit prices and buying an adding machine. There would not be nearly so much objection on our part in going out on the limb and making a lump-sum price on our material if the engineers were willing to make up a bill of material on the pipe and fittings or to show a spirit of cooperation in adjusting final lump-sum prices due to variations in the devices purchased by the contractor.

Water Distribution Hazards

Pollution hazards in a water distribution system may arise from errors in design, installation and operation of that system as well as from hazards on consumers' premises. Precautions to be observed were outlined by Arthur E. Gorman, engineer of water purification, department of public works, Chicago, in a paper before The American Water Works Association, of which the following is an extract.

Design Hazards — The design should provide for maintenance of adequate pressures on the system at all times. Eliminate possibilities for the creation of negative head in the distribution system during shutdowns or periods of abnormal usage. Every section of the system should be served by at least two feeder mains, so that an interruption in supply from one will not result in complete loss of pressure in the area affected.

Installation Hazards—Contractors should be given specifications relating to the prevention of pollution during construction. Avoid setting pipe along gutters and at low points where it may become contaminated by trench drainage water or sewer overflow. Avoid laying sewer and water pipe in close proximity to each other in an area subject to vibration from traffic, etc. Do not use material in water mains which is unsuitable to the ground in which they are laid because of corrosion with subsequent damage to the pipe. Use special fittings on submerged river crossings to turn the pipe downward or upward at land shafts because of the unusual strain at these points.

Operating Hazards—When pressure is low, hazards of all types are greatly multiplied, therefore keep pressure up at all times. Shutdowns for maintenance or test purposes should be kept at a minimum, and consumers should always be forewarned of shutdowns. Field repair gangs should not operate valves without the supervision of a responsible employee familiar with the distribution system.

Consumer Premise Hazards—Cross connections and faulty plumbing introduce numerous possibilities for contamination. Submerged service inlets to storage tanks, vats, reservoirs and other water containers should be prohibited. Where water is repumped in a building and the pump has a capacity out of proportion to the size of the service connection, it is probable that every time the pump is put into service a negative head will be created on the suction side.

Double-Hinged Driver Leads Speed Placing of Batter Piles

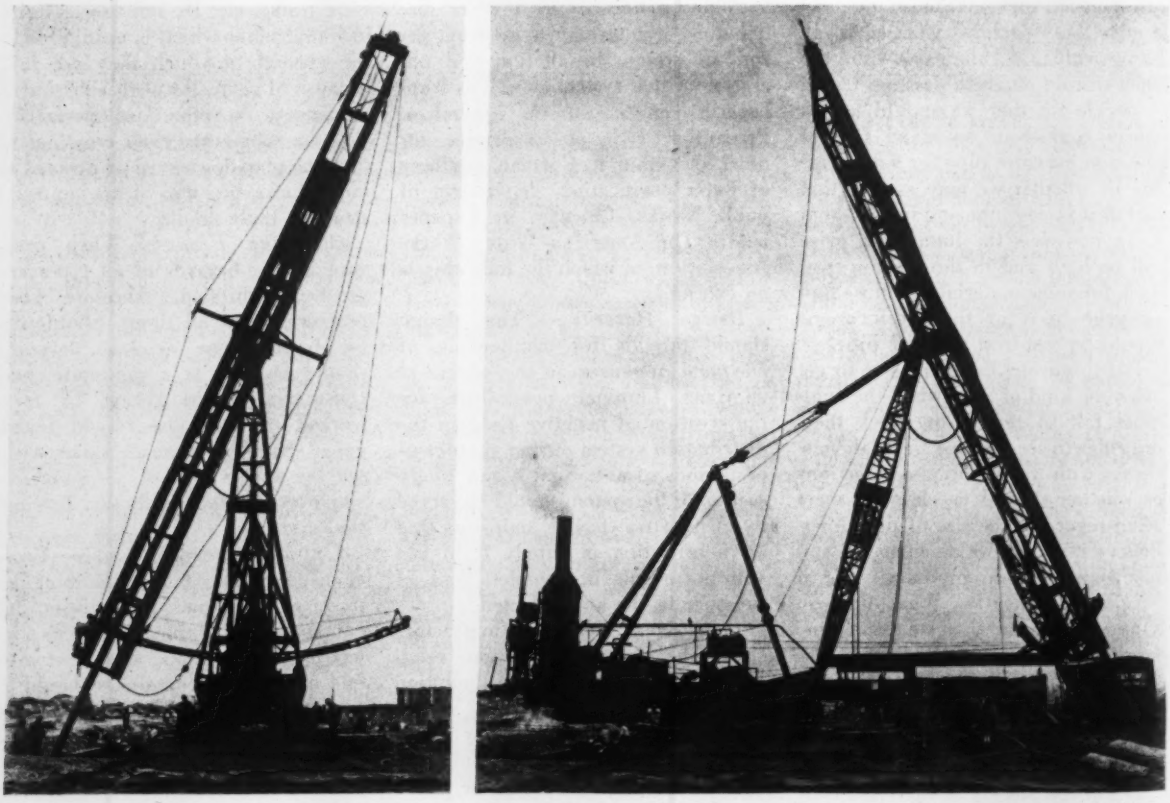
***Contents in Brief**—New design permitting leads to be tilted forward and backward as well as to right and left enabled pile driver to put down an average of 18 piles per shift, despite batters in eight directions, at new naval air base on San Francisco Bay.*

A PILE DRIVER that can drive plumb and batter piles in quick succession was used on a contract recently completed at the Alameda naval air base on San Francisco Bay. Despite the fact that in some pile clusters there were batters in eight different planes, the job was completed with one driver which averaged 30 piles per day, working two eight-hour shifts.

The contract called for 1,580 piles of which 435 had to be driven on a 5 to 12 batter. The contractor estimates that if standard leads, which could be "battered" only in one plane, had been used, the cost of actual driving operations would have been about twice the cost with the special rig used. In other words, a driver of standard type would have to be maneuvered entirely around a pile cluster to reach all the piles and this would have cut progress by 50 per cent.

Actual driving time on batter piles on this job was about one-third more than the driving time on plumb piles; this difference being due to the time required to change the position of the leads and operate the equipment while working out of plumb. The same crew that would be used on a standard driver was adequate for this special rig.

A standard 3-drum pile-driving engine was used for the special rig on which was mounted an A-frame derrick with a steel boom supporting the leads by means of a double joint in which hinge pins were mounted in two planes. One of the pins (in the boom near the top) makes it possible to incline the leads forward, or backward, by means of a horizontal steel beam, or "spotter" attached at the bottom of the leads. In the lead frame, at the top of the boom, the second pin permits tilting the leads in a plane at right angles to the other plane of inclination. This second motion is made with the aid of a steel beam (the "moonbeam") curved in the arc of a circle. Spotter and moonbeam are used with the aid of two auxiliary drums, each operated by a small steam turbine; the spotter is pulled in and out by cables from one of the auxiliary drums and the move-



The manner in which the leads can be rotated for driving piles at angles in one vertical plane is shown at the left, and the manner in which the lower end of the leads can be advanced for driving in a plane at right angles to the other plane is shown at the right. Combination of these two gives a range that meets any requirement for batter piles.

ment of the leads along the moonbeam is controlled by cables running over sheaves at either end of the beam.

To counterbalance leads and their supports, a 15-ton load of rails is used at the rear of the driver frame. The radius of swing is 24 ft. and the leads can pick up a pile 36 ft. ahead of the center pin. The leads are 80½ ft. long; a 75-ft. pile can be put under the 5,000-lb. ram which strikes 60 blows per minute.

All piles on this job were of the composite type consisting of a cast-in-place concrete upper section and a wood lower section. In driving the wooden portion, a corrugated shell was first placed around a steel mandrel at whose lower end the wood pile was attached. A yoke was provided at the joint between wood pile and mandrel to hold this section centered in the leads. The yoke followed down the leads and was removed when it reached ground level.

To save time in spotting piles battered in different planes, a blueprint was prepared giving the exact driver position and lead settings (in two planes) for each pile. That is, with the driver advancing along a predetermined line, a tabulation was made showing, for each pile to be driven, the settings for spotter and moonbeam as well as the exact position of the driver itself to the right or left of the designated line. This program, by its predetermined sequence of operation, greatly simplified moving the driver into position and did away with much lost motion.

The driver was designed by the engineering staff of the Raymond Concrete Pile Co., which carried out the pile driving contract for first unit of the Naval Air Station at Alameda. In charge for the Navy is Commander E. C. Siebert (CEC) U.S.N. Many of the important features of the driver are patented.

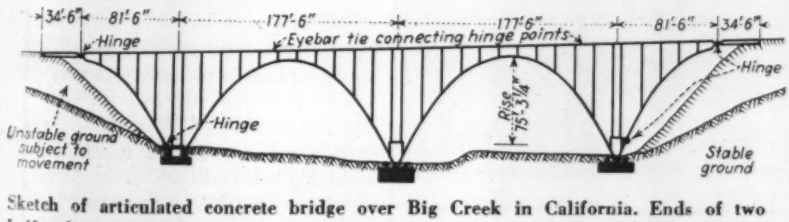
Articulated End Spans Feature Big Creek Concrete Arch Bridge

THE FOUR-SPAN reinforced concrete arch bridge across Big Creek 50 miles south of Carmel on California's coast highway between Monterey and San Simeon is notable for its incorporation of hinged half-arch end spans whose outer ends instead of resting on abutments, are held up by horizontal steel eyebar ties extending the length of the bridge and located in the fascia floor girders. The half arches are hinged at their bases to eliminate stresses which would be induced by elongation and contraction of the ties from temperature change.

Another characteristic of note is that these half arches are joined to the abutments by a hinged girder span, a design used by the California highway department where abutment settlement is expected (*ENR* Nov. 3, 1938, p. 566). Thus, should settlement occur it may readily be overcome by jacking the abutment ends back to grade, the girder rotating on the hinge at the opposite end. This hinge detail also serves to insulate the half arches from any stresses caused by abutment settlement. The general arrangement of the spans is indicated in the accompanying sketch.

The eyebar ties are connected to the ends of the half-arches by structural steel brackets concreted into the arch rib. During construction, the steel ties were pre-stressed for full dead load by means of toggle joints and 125-ton hydraulic jacks placed at the center pier. Thus under dead load alone, the end spans, being tied together through the length of the bridge, balance each other, while, under unbalanced live loads, stresses are carried through the eyebar ties into the main piers. The ties are concreted for their full length in the girders of the deck floor system. However, at each side of each pier an open joint is provided in the deck structure which exposes the ties to the action of the elements. For protection at these points the eyebars are wrapped with asphalt impregnated burlap and encased in a copper sleeve.

The Big Creek Bridge cost about $145,000. C. O. Sparks and Mundo Engineering Co. was the contractor. F. W. Panhorst is bridge engineer of the California highway department. Detailed design was handled by H. E. Kuphal, associate designing engineer. I. T. Johnson was resident engineer on the work for the highway department.



Sketch of articulated concrete bridge over Big Creek in California. Ends of two half-arches are tied together with eyebars running the length of the bridge.

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New Illinois Bridge

Plans for a highway bridge across the Illinois River at Harvard St., Peoria, Ill., are now being prepared by the state Division of Highways, at Springfield, provide for a cantilever through-truss channel span of 536 ft., with anchor arms of 469 ft. The Peoria approach will include six deck truss spans, alternately 208 and 260 ft., together with minor girder spans. On the east approach, there will be three deck truss spans of 156 and 208 ft., and a plate girder viaduct of 1,093 ft., having spans of 86 to 148 ft. With deck trusses spaced 20 ft. 6 in. c. to c. the deck will have a 26-ft. concrete roadway and two sidewalks 2 ft. 6 in. wide. Ernst Lieberman is state highway engineer, and G. F. Burch is bridge engineer of the Division of Highways.

Achieving Low Cost in Low Cost Housing

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Contents in Brief *— Under the current program of federally financed municipal housing, construction costs have been substantially reduced as compared with the earlier programs. The Queensbridge project in New York City, largest in the USHA program, is one of the least costly, $724 a room. Reduction of cost was achieved by efficient layout of room and service space; by specifications that were fair to the contractor; and by careful structural design which reduced floor thickness, provided a large duplication of structural elements, and took advantage of minimum bending moments. For mechanical and electrical equipment, achieving low operating costs rather than low first costs was the guiding criterion.*

ON THE QUEENSBRIDGE low-cost public housing project in New York City, largest in the United States Housing Authority program, the New York City Housing Authority, the local sponsor, has achieved notable reductions in construction costs over comparable projects built under earlier federally financed programs. Based on actual contract prices, this cost is $724 per room, as compared to $1,250 allowed by Congress, a figure which was based on experience under the earlier programs. Architectural planning, specification writing and structural design each contributed in its own way to this good cost showing.

The size of the Queensbridge project, which is located on the north side of the Queensborough Bridge approach on the Queens side of the East River, is indicated by the data given in one of two accompanying tables. The site, originally consisting of twelve 200x600-ft. city blocks, was laid out in six super blocks by closing the intermediate streets. Buildings are grouped around an interior court in each of these super blocks and are entered from the court rather than the street side.

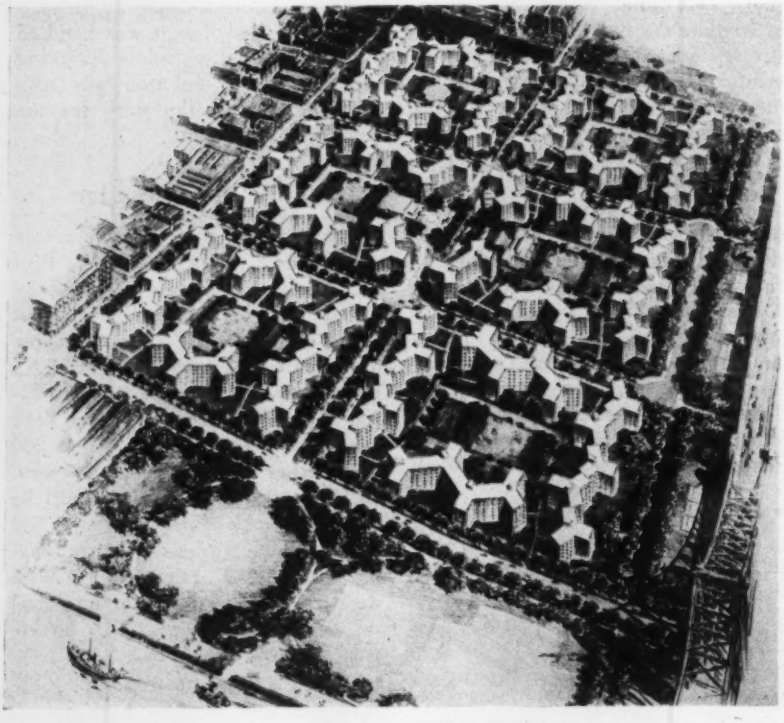


Fig. 1. Architect's rendering of Queensbridge Houses in New York City, Queensborough Bridge at right and East River in foreground. Y-shaped building units are grouped around each of six super blocks into which the 1,100 x 1,540-ft. site is divided.

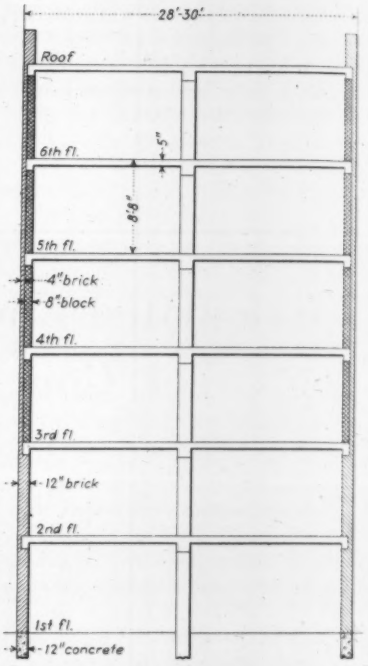


Fig. 2. Relatively narrow buildings permit simple structural frame. Thin slab floors are a feature.

An unusual feature of the project is the use of a 6-story reinforced concrete fireproof building unit which goes to the limit under the multiple-dwelling law in providing twenty full rooms for each stairway on each of the six floors. A "Y" plan for each building unit admits a maximum of light and also affords more privacy, since the apartment windows in interior corners are in planes of 120 instead of 90 deg. Another unusual

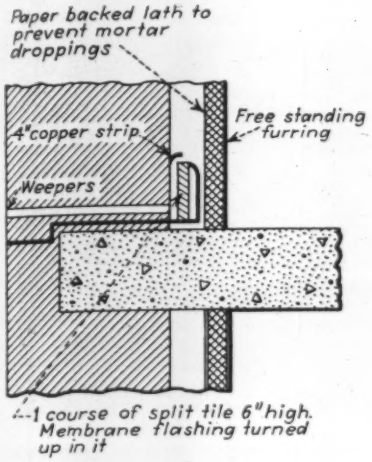

Paper backed lath to prevent mortar droppings
Free standing furring
4"copper strip
Weepers
1 course of split tile 6"high. Membrane flashing turned up in it

Fig. 3. Even in a poor wall, it is claimed, this detail is weatherproof.

feature, in view of the low cost achieved, is the use of concrete pile foundations over a large part of the site. Piles were used where the groundwater level could not be lowered during construction or where rock was deep; elsewhere spread footings were utilized.

Architectural planning included such features as: (a) Elevators which stop only at alternate floors permitting a reduced roof bulkhead height; (b) Closets without doors; (c) Basements limited to only that area required for facilities and entered from the courts rather than from the first floor, thus saving excavation; (d) A minimum of public hall space, and (e) A minimum average length (12.1 ft.) of exterior wall per room.

This efficient architectural planning is probably the largest single factor in reducing costs on the Queensbridge project but the use of a specification written with due regard for cooperation with the builders was also very important. For instance, it is easy to overwrite a specification for the finish of exposed concrete and thus add a large amount to the contractor's bid, whereas a routine industrial finish may be adequate. The role of a good specification in producing a low bid received the particular attention of the housing authority on this project.

Another important element in producing low bids is a thorough understanding by the bidders of the conditions under which they must work. To assure this understanding the housing authority held numerous meetings with the prospective contractors and subcontractors, where all questions which arose in the bidders' minds were thoroughly threshed out. As a result the bidders were able to formulate their bids without making allowances for a large number of unknown quantities and with confidence in the fairness with which the housing authority would handle contractual relations and supervision. These wise policies were originated by the chairman of the New York City Housing Authority, Alfred Rheinstein, who was distinguished as a builder before he undertook his present duties.

Structural economies

Another and an important factor in obtaining low cost lay in the engineering design. In general, the buildings are made up of different combinations of only about five typical units, so that economy is aided by a large amount of horizontal and vertical duplication; this item is of particular importance in reinforced concrete because of duplication in the formwork. Then, as the units are about 30 ft. wide, a very simple structural layout was possible, Fig. 2, consisting of 12-in. bearing walls and a single line of columns and girders down the middle. Finally the use of a 5-in. floor slab resulted in a low-story height, which was established as 8 ft. 8 in., the beams and girders being so arranged that they had a minimum effect in figuring the headroom. The thin floor and the absence of beams produced a saving of from 6 to 12 in. per story over other types of construction, which represented from 3 to 6 ft. in the total height of the buildings. The use of a 3,000-lb. concrete was an important factor in achieving a thin slab and in reducing the sizes of the girders and columns, thus furnishing valuable additional space. Also, the higher-strength concrete kept down the total dead weight of the structure with attendant economies. With the excellent quality and grading of aggregates obtainable in New York City, it was found that the 3,000-lb. concrete cost no more than the average concrete mix called for by the code to produce 2,000-lb. concrete. The code prescribes such concrete to be 1 part cement to 4½ parts of separate volumes of fine and coarse aggregate. It was found that 3,000-lb. controlled concrete could be obtained with a mix of 1 to 5½ resulting in a saving not only of concrete volume but of cost per cubic yard.

Another factor in attaining structural economy consisted in designing the structure as a rigid frame. No direct evaluation of the saving is attempted here, but it may be noted that the average bending moment in a continuous girder was reduced from

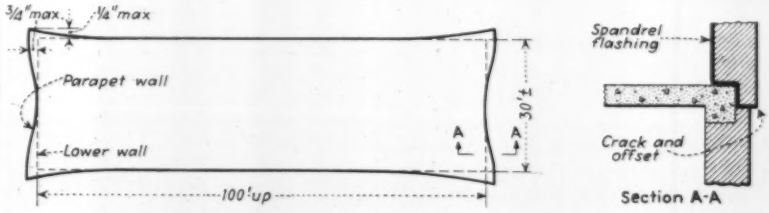


Fig. 4. Sketch showing how wall cracks are formed as a result of floor slab movement. Amount of wall offset is cumulative since brickwork stretches under slab lengthening but does not fully recover under subsequent slab shortening.

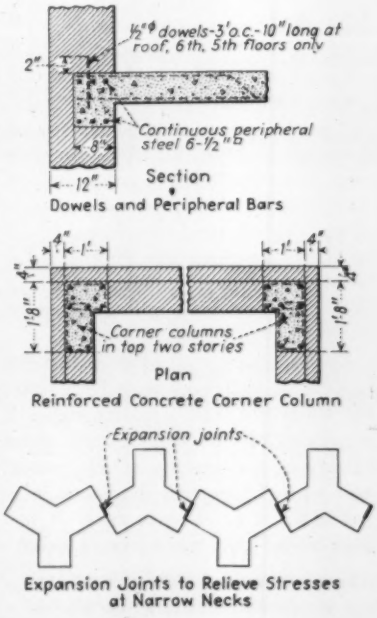


Fig. 5. Expedients used to eliminate cracks on Queensbridge Houses.

Fig. 6. Recent construction views of Queensbridge Houses. At left, a crane with a long boom transfers concrete from truck mixer to roof hopper. At right, placing and vibrating roof concrete; note three peripheral bars at edge of roof used to resist slab movements and thus eliminate wall cracking.

the old value of $wl/12$ to $wl/15$.

As these buildings were limited to six stories in height it was feasible to use a 12-in. brick bearing wall for the lower two stories and a 12-in. wall made up of 8-in. hollow block backup and 4-in. brick for the upper four stories. Fig. 3 shows a system of weatherproofing and furring recommended by the author as proof against leaks even in a poor wall. However, confidence in the workmanship on Queensbridge permitted the elimination of such safeguards as the paper-backed lath, the 4-in. copper strip, the weepers and the split tile and turned-up membrane flashing. These eliminations provided additional savings.

Prevention of cracks

Elimination of cracks in a building would not usually be classed as a saving but in previous housing jobs there has been a great deal of trouble with cracking, and repair charges have been considerable. If no cracks appear in the Queensbridge buildings, a saving compared with other housing jobs will in fact be effected.

Cracks occur most often at the end corners of buildings built with bearing walls and solid concrete slabs. A consideration of the facts leads quite readily to a diagnosis of the causes, and with the correct diagnosis it is not difficult to effect a cure. It has been noted that when cracks occur:

1. They appear at the ends of buildings and are located at or near the level of a plane of weakness in the brick masonry due to membrane flashing.
2. They reach a maximum at the roof and decrease in size and number as the lower floors are reached.
3. The upper wall is offset over the lower at the corners.
4. The offset is proportional to the length of the building, being up to ¼ in. for the end of walls about 30 ft. long and ¾ in. at the end of long longitudinal walls.
5. The offset is greater than can be accounted for by the coefficient of shrinkage in concrete for short walls.
6. Continuous spandrel flashing is generally used.
7. Solid, thin concrete slabs are used. ratios of thickness to span running 1:40 and thinner.

Based on these facts a diagnosis would result in the following conclusions:

1. The slip joint of the continuous flashing provides a plane of weakness.
2. Shrinkage of the concrete while setting shortens the slab.
3. Volumetric changes during construction, as a result of alternate wetting and drying, cause the slab to "work".
4. Temperature differentials between slab and walls, also contribute to the "working" of the slab.
5. A prying action is exerted on the wall by the slab as a result of its deflection or curling while setting.

All of these causes would be accentuated at the corners and, in addition, the prying and relative volumetric changes between the concrete slab and walls would tend to cause cracks diminishing in size on the lower tiers because on the upper levels there would be less dead weight to resist prying and to provide frictional resistance.

All of the above causes have been pretty well understood by different investigators, but they have failed to account for anything like the overhangs noted, such as ¼ in. for a 30-ft. wall and ¾ in. for a long longitudinal wall. The answer to this question is found in the imperfect elastic nature of the brickwork, which permits it to stretch under the lengthening of the slab but does not allow it to return to its original length when the shortening pressure is applied. Thus under alternate lengthening and shortening of the slab there results an accumulative lengthening of the wall above the slab. This, in the opinion of the writer, is the most significant cause of cracks in building walls.

The following expedients, illustrated in Fig. 5, were used on the Queensbridge buildings to eliminate any tendency toward wall cracks:

1. A bond through the flashing was provided by placing dowels in the slab that extended up through the flashing into the brickwork.
2. Reinforced concrete columns were used at the corners in the upper two stories to obtain additional shearing strength at these locations.
3. Peripheral slab reinforcement of six ½-in. round bars was used to control slab shortening due to shrinkage. Inasmuch as the length of these bars remains constant during setting of the concrete they will exert tension on the weak, partly set concrete, producing the phenomenon of invisible or "water" cracks which will prevent the concrete from shortening and exerting a drag on the walls.
4. A shallow spandrel beam was used which, in conjunction with the corner columns, will reduce the prying action at the corners.
5. Expansion joints were used between each Y-shaped building to shorten the continuous length of wall and slab.

Mechanical equipment

In the design of the heating, plumbing, and electrical systems, special attention was paid to securing durable and serviceable systems which would

Size of Queensbridge Project

Number of rooms	12,967
Number of apartments	3,161
Approximate population	11,399
Gross area of land	44.39 acres
Persons per gross acre	256.79
Area covered by buildings	383,951 sq. ft.
Percentage of net area covered by buildings	25.42
Total exterior walls	4.95 miles
Total cubic feet	22,705,000

Cost Data on Queensbridge Project

Cost per room*	$724.00
Land acquisition	1.10 per sq. ft.
Piling	.21 " " "
Construction cost except piling	.42½ per cu. ft.
Plumbing	.044 " " "
Electric	.020 " " "
Hardware	.002 " " "
Heating	.026 " " "
Elevators	.017 " " "

* Does not include refrigerators and ranges.

combine long life with lowest possible operating costs. As a government subsidy makes fixed charges a less important factor than is the case in ordinary commercial enterprises, it was found that the system which was cheapest in first cost was not necessarily the most desirable from the standpoint of long-term operating costs. This is most strikingly illustrated in the case of the heating system, wherein exhaustive studies of operating cost showed that the one-pipe steam system, although considerably cheaper to install, would be much more costly to operate because of the high annual steam consumption, as compared with a controlled system in which the quantity and temperature of steam admitted to the heating system is varied in accordance with outside weather conditions. The latter type was adopted and is now being installed.

Steam is generated in six boiler plants, one to each block, and is distributed at about 10-lb. pressure through underground conduit systems to the various buildings. At each building the steam is automatically reduced in pressure depending upon weather conditions, and is then supplied to the heating system, which is mainly direct radiation, cast iron in living rooms and bedrooms and exposed risers in baths and kitchens. Returns are pumped to the boilers by vacuum or condensation pumps.

Each boiler plant has three firebox-type boilers, equipped with burners and all necessary auxiliaries for burning #6 oil. Five plants each have three boilers, nominally rated at 178.6 hp and the sixth has three boilers rated at 214.3 hp each. The oil burners were so selected that any two boilers would be capable of carrying the entire load at 150 per cent of rating, so that the loss of a boiler through accident or being shut down for repairs would not affect the ability to maintain heat.

The Queensbridge project is being constructed by the New York City Housing Authority, Alfred Rheinstein, chairman, and Allan S. Harrison, secretary.

The architects are the Queensbridge Associated Architects, William F. R. Ballard, chief architect, Henry S. Churchill, Frederick G. Frost and Burnett C. Turner. The heating, plumbing and electrical engineers are Meyer, Strong & Jones, Inc., and the structural engineers Elwyn E. Seelye & Co. Cauldwell-Wingate Co. is the general contractor.

Water Treatment For 100 Consumers

Modern purification and distribution facilities supplant a water supply that had to be hauled for 13 miles

A TREATED WATER SUPPLY for a town having a population of only 625 is sufficiently unusual to warrant some attention to the local conditions and to the plant itself. The town is Murdo, So. Dak., where treatment facilities were completed in April, 1939. W. W. Towne, director of the division of sanitary engineering of the state board of health, reports that there are about 85 water consumers, but that this number will no doubt increase to about 100 now that there is a more satisfactory water supply. The distribution system consists mainly of 4-in. pipe. The following particulars are from a description in *The Clarifier*, a bulletin published periodically by the South Dakota Board of Health.

The town of Murdo has for several years been trying to obtain a satisfactory water supply, but until recently the only drinking water available has had to be hauled some 13 miles. The location is in the south central part of the state, where it is nearly impossible to develop underground supplies. Some years ago a well was drilled to 2,360 ft., but produced only a hot alkali-bearing water. Attention was directed towards an impounded supply, and a dam near the outskirts of the city formed a reservoir which supplied raw water until this source failed during the dry-weather cycle.

In 1935-36 the city with WPA aid, built an earth dam three miles away to impound water from a drainage area of about 12 square miles. Three concrete cut-off walls are built across a spillway cut in the hillside. It was intended to install an infiltration system in the bottom of the reservoir, but before this could be done the reservoir was filled by a sudden run-off. Plans were then made for a filtration plant in the city consisting of a mechanically-agitated mixing basin with 30-min. retention period, two settling basins operating in parallel, with a retention period of six hours, two filters and a 23,000-gal. clear well; storage is provided by an old 60,000-gal. elevated tank. Each filter has a capacity of 100 gpm at a rate of 2 gal. per square foot per minute. They are equipped with flow controllers, but not with loss-of-head gages. Chemical feed equipment includes two dry-feed machines, a ball feeder and a chlorinator.

Laboratory tests on the raw water, confirmed by plant runs, showed that it could be coagulated with 2.5 grains of alum, or it could be softened and coagulated with 8 grains of hydrated lime and 0.8-grain of sodium aluminate. The softening treatment was chosen, as the small additional cost for chemicals would be warranted by the improved quality of the water. Operation for the first few days was in charge of the engineering division of the state board of health, which also trained the local operator, E. A. Weigandt.

Devices for Sampling Undisturbed Soil

***Contents in Brief** — Sampling devices for securing cores of undisturbed soil are illustrated and described; all are devices developed by prominent soils laboratories and actually used in foundation exploration.*

MODERN soils laboratory practice calls for undisturbed soil wherever refinement is required in determining soil properties for sustaining load. In a sample of undisturbed soil the original structure of the soil, its moisture content and even its electrochemical relationships must be kept undisturbed during all the operations of cutting the sample from the natural earth bed, lifting it to the surface and transporting it to the laboratory. Probably the task is never accomplished perfectly and it always requires extreme care but the method is by all odds the most sure for determining actual foundation-soil characteristics.

The practice of taking and testing samples of undisturbed soil is least common of all that are employed in subsurface soil exploration for foundations unless recent study and experimentation in geophysical methods are included. A survey of the methods employed by about forty state highway bridge departments to predetermine subsurface conditions for bridge foundations disclosed the common use of sounding rods and wash borings, and a frequent use of core drilling particularly in rock, but the practice of taking samples of undisturbed soil was reported only for occasional extremely deep and difficult bridge piers. In other fields, examples of undisturbed soil sampling for a wide range of structures and of depths of subsurface exploration are common.

It seemed probable that the exceptions opened the gates to a field of practice that held opportunities for ordinary bridge foundation work. Most state highway departments now have soils laboratories perfectly capable of conducting all the ordinary soils tests. The processes of getting the samples to the laboratory is all that remains to be developed. In general the processes are no more complex than those required for wash borings, except in taking and handling the sample. The sampling device is the main problem and various forms that have been used are illustrated on the following page and described later in the article. None of these samplers is new but with all assembled in one place a comparison of the work of various soils authorities in developing this essential device is possible.

As stated above, the procedure, except that of actually taking the sample, is ordinarily much the same as in wash boring. A casing is sunk and the contents are washed out as in wash boring until the level is reached at which the sample is wanted. Then the sampling tool with the sample container is lowered down the casing by a jointed drive rod or pipe and forced into the soil by jacking pressure, preferably, or by hammer driving. With the sampler driven, it is rotated by the drive rod to break the end bond of the sample with the natural soil bed, or a wire cutter (Figs. 4 and 5) is used or a vacuum hose provides suction permitting a break by direct pull. Lifted to the surface the sample is sealed in its container and goes to the laboratory. A variation exists where, as described later, the sampler (Fig. 2) is operated without casing.

Types of samples

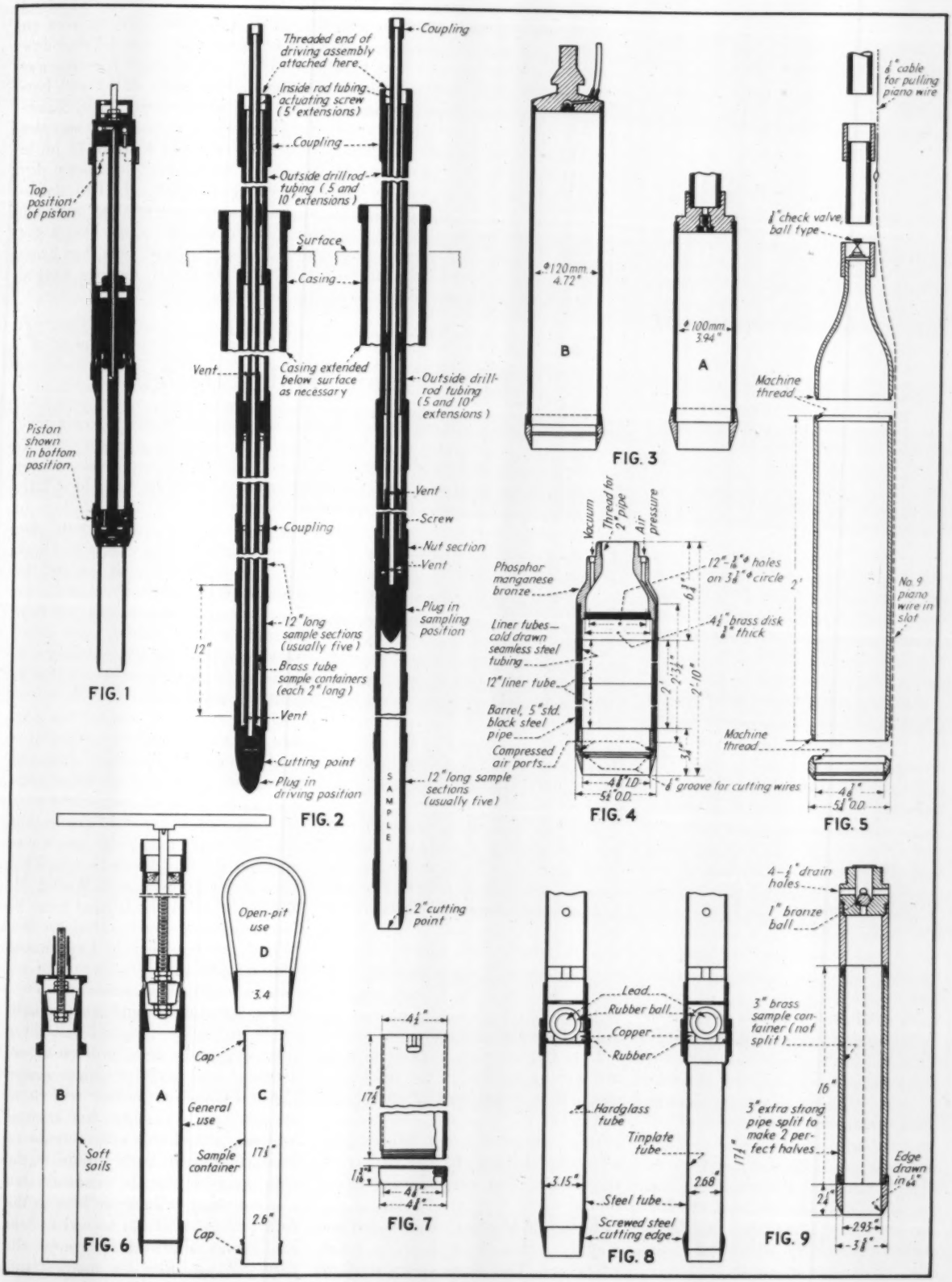
Storstrom Bridge, Denmark (Fig. 1)—Consists of a steel cutting tube lined with a thin brass tube in which the 1¾-in. sample is introduced during the operations. This cutting tube is connected to a piston moving in a cylinder of about 3 in. inside diameter. In the center of the cylinder is a fixed guiding rod ending in a bottom plug, which acts as a piston in the brass tube, when this tube, together with the steel cutting tube and the main piston, is moved downwards in the cylinder by water pressure acting on the upper side of the main piston.

California Division of Highways (Fig. 2)—Casing is not required for depths to 100 ft. except in free-flowing material. On the foundation study for the San Francisco Interurban Bay Bridge Terminal and Viaduct, 70 to 90 ft. of casing was used to seal off overlying strata of free flowing eolian and marine sands. Boring and sampling operations were then satisfactorily continued through marine clay and clayey sand to bedrock at depths up to 220 ft. without further casing, at a saving of one-third to one-half the cost under previous methods.

The samples unit consists of a cutting point, sampler sections, couplings, 2-in. brass tube sample retainers, and a plug screw-and-nut assembly. The important element is the plug assembly: (1) it plugs the sampler until the depth is reached at which samples are desired; and (2) it provides a seal against suction immediately above the top of the sample. Samples are taken by (1) driving the sampler as a plugged tube to the desired depth; (2) retracting the plug and forcing the open sampler into undisturbed material; (3) retracting the plug further to effect an air tight seal above the sample; (4) withdrawing the entire sampler unit to the surface.

Foundation Soils Research Laboratory, Cairo, Egypt (Fig. 3)—In sampling soils of the Nile valley (clays and silts) after testing various forms of samplers, selection was made of the two shown after a design by A. Casagrande. The cutting edge was carefully machined 2 mm. smaller in diameter than the sampler barrel. The use of a wire to shear off the sample before pulling did not prove very satisfactory in sampler *A;* also the valve at the top to release the water failed to act and the sample slipped out in pulling. Later a larger sampler *B* was made with a rubber tube connected to the water exit by which a small hand pump applied suction. This proved generally satisfactory.

Harvard Graduate School of Engineering, Cambridge, Mass. (Fig. 4)—Sampler for general use after a design by A. Casagrande, director of the laboratory of soil mechanics. All



Principal soil sampling devices used in this country and in Europe to obtain undisturbed samples of deep-lying strata.

essential features are described on the drawing.

U. S. Waterways Experiment Station, Vicksburg, Mass. (Fig. 5)—A sampler having the wire cutter distinctive of the Casagrande sampler, Fig. 4, but without the inside sample container tube, and substituting a ball valve for the air-pressure and the vacuum hose.

Laboratory of Soil Mechanics, Delft, Holland (Fig. 6)—Deep and shallow soil samplers employed by the laboratory are shown. Deep sampler *A*, with the tin sample container *C* in place, is inserted in the cased bore hole, lowered to the bottom and forced into the soil by a rod of coupled pipe. In this operation the rubber valve is kept open to allow any water to escape; when the sampler has entered the full depth into the soil, the valve is screwed down by the pipe rod, the sampler is rotated to shear the sample loose and rod and sampler are lifted out of the cased hole. Shallow sampler *B* is like the deep sampler except that it is shorter and weighs less so that it can be more easily handled in sampling shallow holes. Surface sampler *D* is used to take samples from the bottoms of test pits. The deep sampler has been operated to depths of 115 ft.

Building Research Board, England (Fig. 7)—The tool consists of a thin cylinder of steel with a hard steel nose embodying a cutting edge. The principal features are: (1) The cutting edge is slightly smaller in diameter than the diameter of the cylinder. For different types of soils different nose pieces are used to allow different degrees of "release." (2) A slight "release" on the outside of the tube cuts down resistance on the outside. (3) A ball valve at the top assists in retaining the sample during extraction.

The tool is driven into the ground by percussion with a hammer weighing about 50 lb. and when the tool is full it is rotated once to assist in breaking the sample at the bottom before extracting. The sample of soil obtained with the tool is a cylinder about 4¼ in. in diameter and 15 in. long. In removing the sample the coring tool is disconnected from the boring rods and then the sample is pushed through the wider end of the tube into a close fitting tin.

Department of Public Works, Rotterdam, Holland (Fig. 8)—At Rotterdam soft upper strata (clay and peat) overlie sand. In planning for the vehicular tunnel under the Maas River it was necessary to have reliable means of securing undisturbed samples. The samplers shown as Fig. 8 were developed; they are much alike except that one has a glass inner tube for holding the sample and the other has a tin inner tube; the glass-fitted sampler gave the great advantage of visual inspection, but the one with the tin container showed less resistance to penetration.

Moran, Proctor & Freeman, Consulting Engineers, New York (Fig. 9)—Preparation of the site of the New York World's Fair called for underground exploration of Flushing Meadow, about 900 acres in area on Long Island. The natural meadow land is low and marshy. The area was explored by a series of 61 soil borings, 13 of which were 4 in. in diameter from which undisturbed samples were obtained; and 48 were 2½ in. in diameter from which ordinary dry samples were obtained. The undisturbed samples were taken with the sampling device shown as Fig. 9, the sample being secured in a thin brass tube. The depths of samples ranged up to 80 ft.

Rigid-Frame Bridge Design

With the rapidly extending use of bridges of the rigid-frame type there have developed numerous investigations as to the general and detail features of their design. Two such studies relating to reinforced concrete bridges have been carried out at the Engineering Expriment Station of the University of Illinois, in cooperation with the Portland Cement Association.

The first of these studies, dealing particularly with the stresses in the sharp angles between the slab or deck and its supporting walls, is described by Frank E. Richart, Thomas J. Dolan and Tilford A. Olson in Bulletin No. 307 of the Experiment Station. The tests were made on L-shaped knee frames 12 in. thick and 8 ft. 9 in. high over all, some having sharp corners and others having triangular and curved fillets. The objects of study were the effects of the following: (1) size and form of fillet, (2) chamfering of outside corner, (3) compressive reinforcement, (4) plastic flow and (5) a large amount of tensile reinforcement. Conclusions drawn from the tests follow:

In general, the initial cause of failure was by tension in the reinforcement. With 1 per cent of steel reinforcement the localized compression at the corners did not appreciably affect the ultimate strength of any of the frames. The strengthening effect of the fillets was largely due to the reduction in bending moment and the slightly increased depth at the point of failure. The elastic properties of the frames were affected greatly by the fillets, large fillets increasing the overall stiffness by 50 to 70 per cent. Chamfering the back corners had very little effect on strength or stiffness. Compression reinforcement was effective in stiffening, but added little to the strength, because of failure in tension. Sustained loading tests also showed the stiffening effects of fillets. After 15 months of such loading the concrete strains, deflections and rotations had increased to two or four times their initial values, even under light working loads. The increase was least when compressive reinforcement was present.

The second study was for the purpose of determining the action of a rigid-frame structure when subjected to various loads and abutment displacements. Tests to destruction were made on two 18-in. rigid-frame ribs of 48-ft. span and 15-ft. height, as designed for a highway bridge. This investigation, in charge of Wilbur M. Wilson, Ralph W. Kluge and John V. Coombe, is reported in Bulletin No. 308 of the Engineering Experiment Station, with an interpretation of results as summarized below.

The structure should not be subjected to active longitudinal force at the end of the deck, as from an expanding road slab or other cause. Flexural failure at the knee will cause the structure to collapse, but a small increase in thickness will increase its flexural strength. Such failure at the crown may injure the roadway, but will not cause collapse as long as the deck retains its ability to resist shear and thrust. Flexural failure at the base will not affect the moment due to load at other sections, nor cause collapse if the base retains its capacity to resist shear and thrust.

Stress, Strain and Structural Damage

H. F. MOORE

Professor of Engineering Materials, University of Illinois, Urbana, Ill.

Contents in Brief—Extracts from the Marburg Lecture before the American Society for Testing Materials in which Prof. Moore points out some of the defects in our present structural theories as they relate to elastic action.

A TACIT ASSUMPTION in studying structural and machine parts is that when the critical stress for structural damage as determined by a simple laboratory test of the material is exceeded *at any point* in a part then that part has suffered structural damage. Actually in all materials there are minute areas of high stress; that is, the material is by no means perfectly homogeneous. But small inelastic deformations cut down the peaks of these localized high stresses.

Localized stress relief

I doubt very much whether there are any machine parts in service which, over microscopic areas here and there, have not been stressed beyond the elastic range. I further believe that if it were not for this relief of stress by localized inelastic action it would be very doubtful whether our structural and machine parts would stand up in service. Carefully dried plaster of Paris shows very little inelastic action right up to fracture, and even if a very strong plaster of Paris could be developed no one would dare to make a crane hook out of it, or out of ordinary gray cast iron for that matter.

The resistance of a beam to structural damage by permanent distortion depends to a considerable degree on the behavior of its material when the action is no longer perfectly elastic. That is, our ordinary stress-strain formulas—the whole mathematical theory of elasticity, in fact—are based on the behavior of an ideal material which would not behave quite as our actual materials do.

This ideal material is assumed to be perfectly homogeneous and isotropic (equally deformable in all directions), and Hooke's law is assumed to hold. A glance through the microscope disposes of the question of homogeneity of timber, concrete, brick and the ordinary structural metals. Tests of single crystals of metal or specimens of wood dispose of the assumption of isotropy. Hooke's law is at best a close approximation. Thus the theory is based on three assumptions, two of which are false and the third of which is an empirical approximation.

However, we can regard all our structural materials as having statistical homogeneity. Structural damage, at least under static load, rarely if ever takes place until an appreciable volume of material is involved —a volume comprising thousands of grains or of fibers, hundreds of thousands of space lattice cells, and millions of atoms. That makes it seem as if statistical methods might be useful and reliable guides, and since no better theory has as yet been developed than the mathematical theory of elasticity, and since it may be regarded as statistically true, we propose to retain it and use it until a better method has been shown to be usable.

Types of structural damage

Four types of structural damage due to mechanical causes are: (1) elastic deformation, (2) damage by inelastic action, (3) fracture, and (4) damage by continuing deformation or creep.

Structural damage by elastic deformation may be illustrated by considering the case of a steam-turbine disk with an ineffective shrink fit on the turbine shaft. Elastic deformation due to centrifugal force may make the disk loose on the shaft, and such looseness would be primary structural damage. Even more serious secondary damage might follow.

In spite of the non-homogeneity and non-isotropy of actual materials the theory of elasticity is a very satisfactory guide indeed for designing against structural damage by elastic deformation. Viewed microscopically, material is not homogeneous, but viewed macroscopically a structural or machine part under elastic stress behaves as if it were homogeneous within the tolerances of careful machine work.

When material yields

Probably the type of structural damage most feared by designers and builders of metal structures is failure of the elastic strength of the material with consequent permanent distortion. Appreciable permanent distortion itself usually constitutes structural damage. The secondary effects of failure of elastic strength are frequently more serious than the primary. If any considerable volume of the steel in a column is compressed beyond its elastic strength there is danger of lateral buckling of the column followed by disastrous collapse.

Structural damage by inelastic action may also consist of a redistribution of stress that may be injurious. For example, in a welded or riveted truss failure of elastic strength in a strut may cause serious flexural stresses in joints or in members not designed for flexure. Of course in machine-tool parts and delicate measuring instruments even a very small permanent distortion may constitute serious damage.

The metallurgical microscope and the X-ray diffraction pattern have given us a picture of the failure of elastic strength of a piece of metal as the aggregate of a large number of localized failures of individual crystalline grains along planes of atomic weakness. Failure of a single crystalline grain in a structural or machine part is rarely to be regarded as structural damage to the part as a whole.

Just how many grains must fail, and how closely together they must be to cause appreciable damage is a matter for empirical judgment based on experience.

In some of the A.S.T.M. standards the limiting distortion which shall be regarded as causing structural damage is placed at some definite permanent set—a permanent set of 0.2 per cent of any given gage length is sometimes specified. In setting such an arbitrary limit we are recognizing the fact that slip within grains must be widespread before damage is done. We are again assuming that our non-homogeneous material may be considered as "statistically" homogeneous.

Fracture always progressive

Perhaps the most dramatic type of structural damage is fracture. It is natural to think of fractures as occurring in the manner described by Oliver Wendell Holmes in his poem on the wonderful one-hoss shay, whose failure occurred "all at once and nothing first, just as bubbles do when they burst". But the high-speed motion-picture camera shows that neither bubbles nor pieces of wood or metal fracture "all at once". They fracture progressively, but so rapidly that the eye can rarely follow the progress of the spreading crack.

The beginning of fracture is a highly localized phenomenon. The changes of pattern given by an X-ray spectrograph seem to picture the breaking up of crystalline grains of metal into "crystallites," units larger than a space lattice cell but smaller than a crystalline grain. Somewhere in this region between the atomic size range and the microscopic size range, fractures seem to start.

Endurance and creep

Fracture by a spreading crack under repeated load has come to have the misleading name "fatigue". An outstanding characteristic of a "fatigue" crack is that it develops with very little distortion of the part as a whole. It seems as if the ductility of the material has been destroyed. However, test specimens cut from material as near the crack as possible show no loss of elongation or reduction of area.

The metallographic microscope shows fatigue cracks starting along slip lines, although by no means all slip lines develop into cracks. Progressive cracks, once started, soon tend to take a direction at right angles to the maximum tensile stress. Repeated-stress tests show the localized nature of fracture far more clearly than do tests under steady load.

Statistical reasoning does well enough for action involving macroscopic volumes of material but it is not so reliable for microscopic volumes, and it is in a microscopic or perhaps sub-microscopic volume of material that a spreading crack usually starts. Modification of our ordinary formulas for stress and strain by the use of shape factors, size factors, factors of sensitivity to "stress raisers" (holes, notches and the like) seems to be our most desirable course *at present*.

A type of structural damage which produces distortion much as inelastic action does, but whose nature is probably quite different, is "creep," which may be defined as distortion which under steady load continues with time. Examples of creep are the continued bending of a glass rod under a steady load, the slow month-by-month expansion of lead pipes under internal pressure, the slow flow of concrete and some natural stones under steady compression, and, most important of all, the slow creep of metals at elevated temperatures.

Under inelastic action below the critical temperature, cold work stiffens the metal and stops distortion; above this critical temperature (more or less well defined) the metal acts somewhat as if it were a very viscous liquid. However, the rate of creep of a flange bolt or a lead cable sheathing is not, in general, directly proportional to stress, as is the case for viscous flow.

Continuing creep in metals or concrete is a direct cause of structural damage. When flange bolts in a steam line begin to creep, leakage soon appears; when lead sheathing on electric cables creeps, insulation voids are sometimes caused inside the sheathing and insulation troubles appear; when concrete in a column creeps, stress is transferred from the concrete to any longitudinal steel rods, sometimes to the extent of stressing the rods to their yield strength.

In evaluating the structural damage due to distortion caused by creep, the material may be regarded as a "statistically" homogeneous body. Creep seems to be a localized phenomenon, but the locations where it occurs are scattered throughout the metal of a structural or machine part.

* * *

Radio Service for Snow Plows on California Roads

Successful experiments with radio commuuication between snow plows in service and their operating headquarters have been made in California this past winter, following the example of the state of Washington and with assistance from the Washington state highway department. As explained in "California Highways and Public Works" for February, by T. H. Dennis, maintenance engineer, the California highway department decided last August to equip one road district.

The transmitter sets for the stations are designed to work on standard house current of 110 volts, 60 cycles, or on a 12-volt truck battery current, the change involving merely the shifting of the power plug from one socket to another. Similar transmitters on the motor plows operate on telephone only, with a power of 50 watts supplied from the truck battery. Receivers for the stations have speakers mounted in them and can be operated on 110-volt alternating current or 12-volt direct current by simply turning a knob. The receivers on the rotary plows, for 12-volt current only, have a separate speaker in the cab.

At some of the stations, three 100-ft. fir poles are erected in the form of a triangle to carry the antennae, while trees are utilised at other stations. Antennae for the plows were more difficult to design. When not in use the antenna lies back over the cab and extends only 12 in. above it. For transmission, it is raised to a vertical height of 23 ft. by mechanism in the cab, this operation requiring less than ten seconds.

Every morning, before the men go to work, there is a rapid exchange of weather information for about 15 minutes, so that each station then knows the weather and temperature at all points and the forecast for the next 24 hours. Throughout the day, plows in operation report each hour. During storms there is a day-and-night watch.

A New Soil Compacting Device

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Contents in Brief — A combination of water jetting and vibration developed in Germany for soil compaction. Two foundation operations described. Application to embankment solidification indicated.

A METHOD of soil compaction, which involves introducing water into the soil and simultaneously resettling it by vibration, has been successfully used on important foundation work in Germany. Essentially the principle is that injected water enters the soil and the vibration causes the solids to settle into compact structure. Two examples of foundation construction, one at Nuremberg and another at Berlin, indicate the practical application of the process in this type of construction. Its application to embankment solidification is represented by dam construction at Renchen, Germany. In all these works the soil was sand. The name that has been given to the method is vibroflotation.

Solidifying successive cylinders

At Nuremburg the site for a large government building with heavy concentrated loads was fine sand overlying rock at a depth of about 50 ft. Heavy groundwater pressures prevailed in the lower parts of the sand layer and it was decided to use the vibroflotation process to compact the sand to a greater load-carrying capacity. This was the first use of the process in actual construction and it was carried out by solidifying to rock cylinders of sand spaced 5 ft. apart which was close enough so that the cylinders intersected. The procedure was as follows:

A 16-in. cased well was bored and the vibroflotation device in operation was settled into it until rock was reached. Then the casing was withdrawn 2 ft. The device consisted of a vibrator with nozzles. When at the bottom of the well sand was filled in and jetted and vibrated until about a 2-ft. layer was solidified reaching laterally well out beyond the 16-in. boring. Then the device was pulled up 2 ft. and another layer was solidified. This procedure was continued to the surface and then another boring was begun. A satisfactory compaction for the foundation work was obtained, the bearing capacity of the sand being more than doubled, but it was obvious that the preliminary well boring added a prohibitive cost.

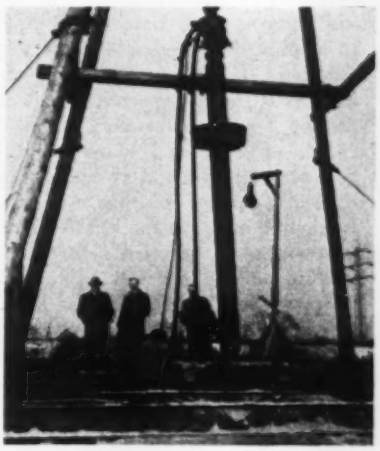

Fig. 3. Vibrator and jetting device used for soil compaction for a building foundation, Berlin, Germany.

An experimental study of the action of vibroflotation indicated that the combined jetting and vibration produced a soil condition that would enable the device starting from the surface to sink by its own weight to any depth required. A special heavy device indicated by Fig. 3 was then developed and used on a foundation job in Berlin under the supervision of the German Society for Research of Soils Mechanics.

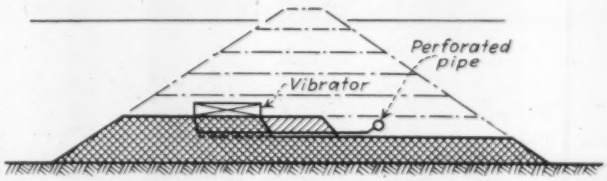

Fig. 2. Procedure followed in compacting an earth dam by vibrating and jetting.

Fig. 1. Solidity of compacted soil in the Berlin building foundation indicated by test pit and gallery.

New method successful

At Berlin a building foundation area of 6,202 sq.ft. was compacted to a depth of 23½ ft. during the winter of 1937-8. As reported for the society, the vibrator was sunk 144 times on a lot area of 63x99 ft. to an average depth of 23½ ft. compact-

ing an area each time of 43 sq.ft. In sinking the speed was about 3 ft. a minute; the pulling speed was 3 ft. in 5 to 10 min. to permit full compaction. During compaction some 400 cu.yd. of borrowed material were added; levels taken after compaction showed a surface subsidence of 2 in. Computations gave the relative compactness as 43 per cent before compaction and 80 per cent after compaction. The permissible loads before and after were respectively 3,000 lb. and 6,000 lb. per sq.ft.

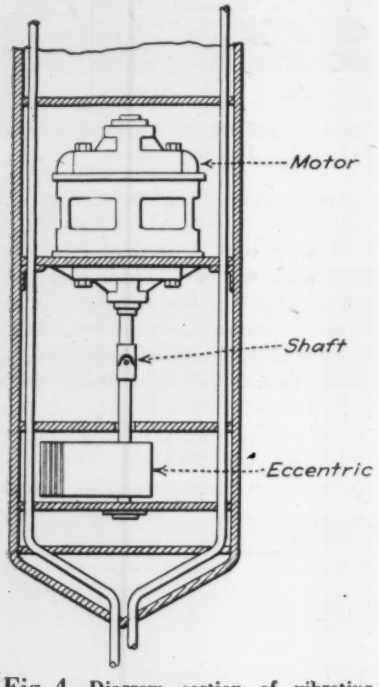

Fig. 4. Diagram section of vibrating and jetting unit.

As shown by Figs. 3 and 4 the vibrator is of the internal type and is of considerable weight requiring a head frame to handle it. To observe the degree of compaction the test pit and gallery shown by Fig. 1 were excavated.

Embankment compaction

Surface vibration is effective in compacting soil to a depth of not over 6 ft. Fig. 2 indicates the procedure at the Renchen dam. For compacting each layer five perforated 2-in. pipes were laid across the dam at 4-ft. intervals on the surface of the previously compacted layer. The fill was then placed as indicated, water was introduced into the five pipes at a pressure of 0.1 to 0.2 atmospheres. The surface vibrator was then started over the first pipe and as soon as water showed on the surface this pipe was closed and the vibrator was shifted to the second pipe. As vibration over each pipe comes to an end the pipe is partly withdrawn. The relative density of the compacted dam that was obtained was about 100 per cent.

Vacuum Frequency—The Measure of Hazard in Cross-Connections

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***Contents in Brief**—Cross-connection surveys of plumbing systems require more than simple inspection of pipes and fixtures. The potential hazards are in large measure determined by the frequency with which a vacuum may occur in the water piping. How this vacuum frequency is measured and what results are obtained is the subject of this article.*

TO PERMIT a better understanding of the results of a WPA plumbing survey of federal buildings in New York City and Detroit a study was made of six office buildings for the purpose of determining, if possible, the frequency with which a vacuum or a less-than-atmospheric pressure occurred in the water supply piping. In this survey, the plumbing in various federal buildings in the two cities was inspected in order to determine the number and seriousness of existing cross-connections. The results of the inspections brought out the lack of information upon which to base conclusions concerning the potential hazard represented by the cross-con-

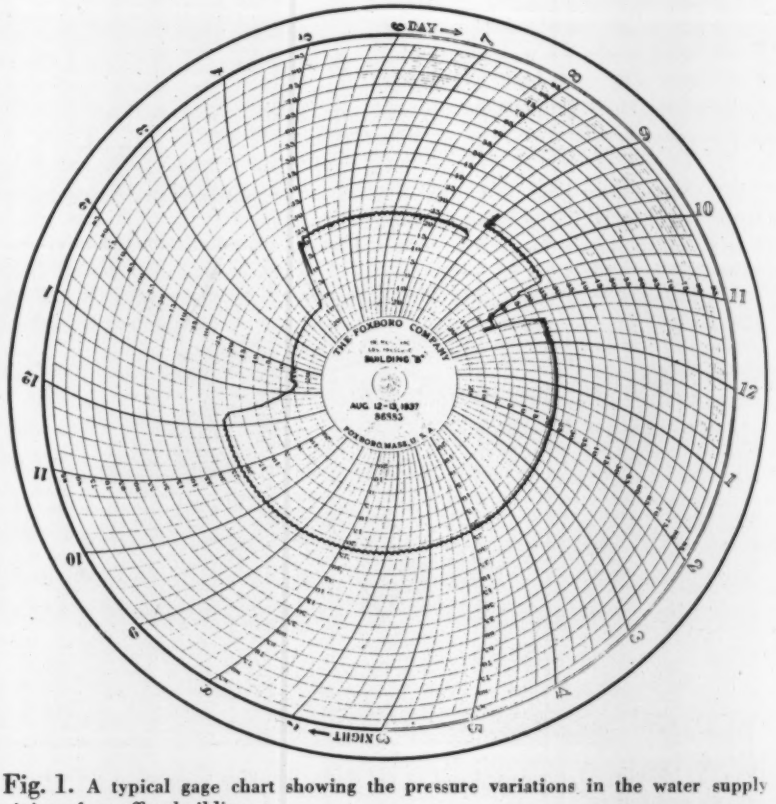

Fig. 1. A typical gage chart showing the pressure variations in the water supply piping of an office building.

nections encountered. Since an important factor in determining the danger of faulty plumbing and improper piping is the frequency with which a vacuum occurs, it was imperative that data on this phenomenon be obtained.

The method first adopted to determine the vacuum frequency in a building was to install a pressure-vacuum recording gage in that part of a building most likely to evidence a vacuum. (This was determined after a visual inspection of the building's water system.) Twenty-four hour chart records of the pressure fluctuations in that part of the building were obtained for the length of time necessary for a vacuum to be recorded.

Measuring vacuum frequency

This initial procedure was soon changed because of limitations imposed through occupancy of the building and to the length of time necessary in some instances for a vacuum to be recorded. The revised procedure adopted was based upon the probability theory. Pressure chart records (Fig. 1) were obtained for varying lengths of time in the different buildings at points most likely to show a less-than-atmospheric pressure. From the chart for each building a statistical array was made by selecting the lowest pressures recorded in each consecutive 15-min. interval and arranging them in order of magnitude. The frequency of occurrence of each interval of pressure was determined and recorded. From this, the per cent of pressures recorded less than each stated pressure was calculated. These figures were then plotted on both arithmetic and logarithmic probability paper against the stated pressures (Fig. 2).

Extension of the lower ends of the resulting curves to intersect the line of one pound of pressure permitted an approximation to be made of the frequency with which a pressure of less than one pound per square inch could be expected to occur. This figure was taken in preference to the intersection of the curve with the line of zero pressure in order to permit the reading of corresponding values from the logarithmic plats.

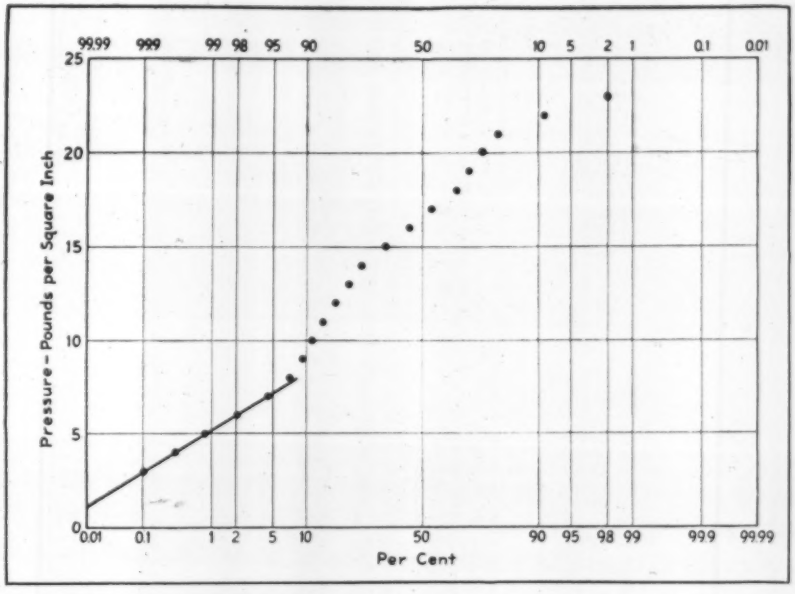

Fig. 2. Arithmetic-probability chart on which the per cent of observed pressures less than stated pressures is plotted against stated pressures.

The frequency with which a pressure of less than one pound per square inch could be expected to occur was considered as the vacuum frequency of the building. Assuming that a vacuum would occur most frequently at the point at which the gage was installed and excluding all unpredictable circumstances and any unforeseen influences, such as the breaking of pipes in the building which would affect points in the system unrelated to that at which the gage was installed, it may be stated that a vacuum could not be expected to occur more frequently in a building than the per cent of time indicated by the vacuum frequency.

Evaluating the hazards

Therefore, using the vacuum frequency of a building as an index, the relative hazard represented by a number of defective plumbing fixtures or installations might be evaluated. Also, a comparison of the dangers inherent in the plumbing systems of two buildings may be accomplished. For instance, in Table I which lists the vacuum frequencies in the six buildings investigated as determined by the modified procedure outlined above, it is apparent that the same number of potentially hazardous cross-connections in buildings B and C would result in an extreme difference in the dangers represented by the complete plumbing installations in these two structures. Whereas, in building C the defective fixtures may present a minimum of hazard due to the low vacuum frequency, the presence of these same fixtures in building B would indicate greater potentialities for harm.

The variability of the vacuum frequencies of the six buildings studied as shown by the results recorded in Table I points to the necessity for a closer examination of the factors influencing the dangers of cross-connections and defective plumbing fixtures. Condemnation of a plumbing system or installation in a building requires more than a simple inspection of the various connections and fixtures. Adequate study and investigation should be given to the different factors influencing the creation of a health hazard in the water system before conclusions as to the degree of hazard presented are drawn.

TABLE I RESULTS OF A STUDY OF VACUUM FREQUENCIES IN SIX BUILDINGS

Designation of Building	Number of Observations	Lowest Recorded Pressure	Vacuum Frequency*— Per cent	
			From Arithmetic Probability Plot	From Logarithmic Probability Plot
A	3,582	2 lb. per sq. in.	0.013	0.0037
B	3,495	15 in. mercury vacuum	25	25
C	697	24 lb. per sq. in.	Negligible	Negligible
D	3,854	1 in. mercury vacuum	0.24	0.23
E	1,944	2 lb. per sq. in.	0.0051	0.0021
F	2,570	1 lb. per sq. in.	0.015	0.0038

* The vacuum frequency recorded here represents the per cent of time that a pressure of less than one pound per sq. in. could be expected to be recorded in a series of lowest pressures obtained from consecutive 15 min. intervals.

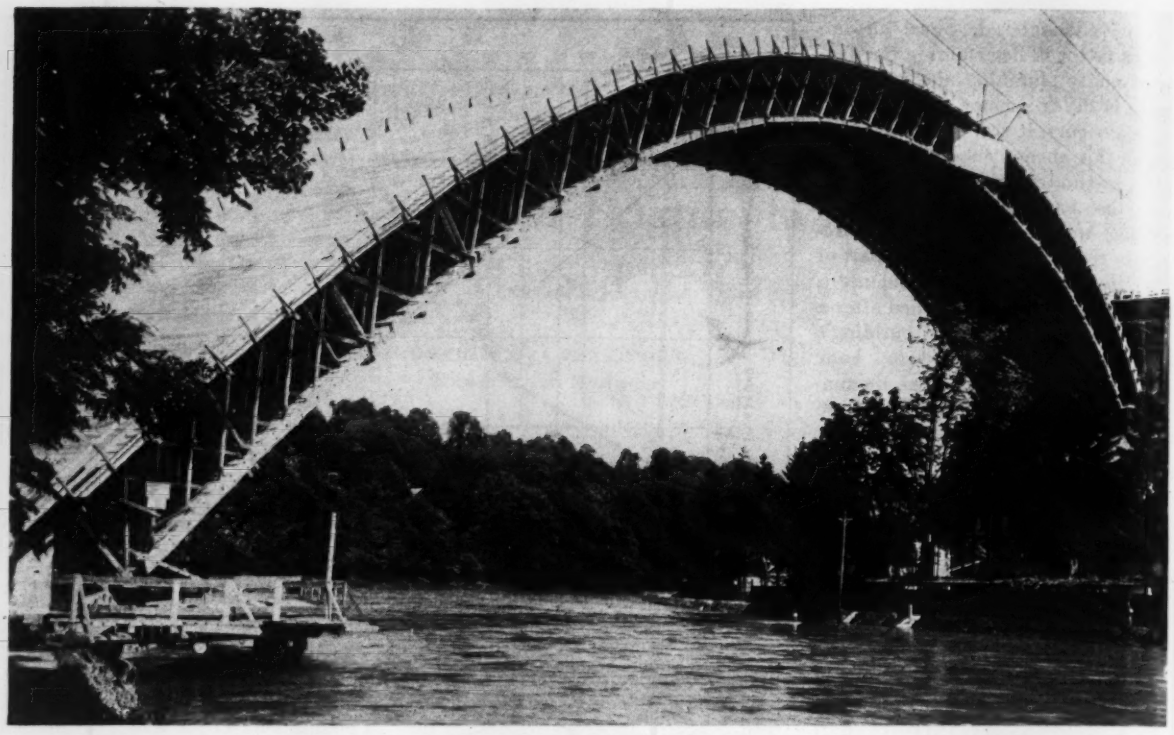

FIG. 1. THE TIMBER ARCH USED AS A CENTER FOR THE NEW CONCRETE RAILWAY BRIDGE AT BERNE, SWITZERLAND.

A Bold Arch Center

H. KAEGI and A. J. LUCHINGER

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Contents in Brief — Craftsmanship supplements bold timber-arch design in centering for 460-ft. concrete arch at Berne, Switzerland. Shop-work and field erection described.

UNUSUALLY BOLD timberwork was required in building the center for the 460-ft. concrete arch span of the new railway bridge at Berne, Switzerland. Conditions at the site made a supported center inadvisable and a clear-span timber arch was adopted. This gave clearance to important buildings on one shore and eliminated the danger from floods to falsework in the river. Computations also showed that an arch would be a more economical form of centering. A timber arch of 450-ft. span is an impressive structure, as the several views and drawings given here indicate, and methods of fabrication and erection present formidable problems to be solved.

The bridge is for a four-track railway, a relocation for about a mile of the Swiss federal railway around the city of Berne, that will be put in operation in 1941. It crosses the River Aare with a 460-ft. concrete arch with a rise of 100 ft. Two 83-ft. girder spans at one end and four at the opposite end form the approach structure. The arch ring is hollow, composed of top and bottom slabs and four vertical ribs. A cross section is shown by Fig. 3. The arch ring is 41 ft. wide, 15 ft. deep at the springing lines and 10 ft. deep at the crown. Four-column bents rising from the arch, with columns directly over the ribs, carry four lines of girders

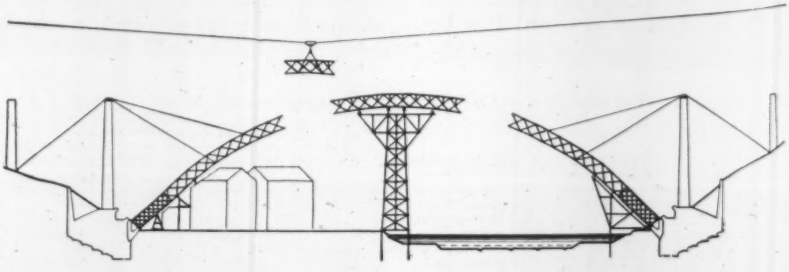


Fig. 2. Falsework for erecting the first two ribs of the timber center for the arch.

supporting the deck slab which is 51 ft. wide and carries a railway track centered over each girder.

The computed weight of the arch ring ranged from 28 tons per lineal foot at the springing line to 18 tons at the crown. One purpose of the box-section arch ring was to reduce as much as possible the task of the center under this load. The lower slab of the ring was concreted first and completely closed. The ribs were then concreted and finally the top slab. By this stage construction each completed part of the arch ring took on successive fractions of the dead load. For example, in the first stage the lower slab, with the haunches, was poured and completely closed. Experiments indicated a bond resistance between timber and concrete of 9 lb. per sq.in. The lower slab and the timber arch were thus assumed to act as a combined arch to carry the load of the ribs and the upper slab.

The timber centering was designed as an arch with fixed ends, and as the upper and lower chords are always in compression, it was not necessary to make special provision for rigid fixing. The total width of the centering is 43 ft.; it consists of 12 trusses of identical design. The theoretical height of the trusses is 11 ft. The trusses were set 4.5 in. higher at the crown to allow for deflection due to shortening from shrinkage and under load. Both the upper and lower chords of the trusses are made up of six timbers having a total width of about 3 ft. The truss timbers were normally not larger than 4x12 in. To provide for easy erection joints were arranged at least every 44 ft. The joints were connected with split-ring dowels (Locher system).

The contractor began concreting the lower slab Aug. 26, 1938, and the full arch ring was completed Oct. 1, 1938. The deflection under the full load was 3¼ in.

Fabrication and erection

The trusses were fabricated in the closed carpenter shop of the contractor; here the trusses were laid out and truss members cut, bored, grooved and assembled. After fitting in the carpenter shop the timbers were shipped to the building yard, reassembled in truss sections of 21 and 42 ft., of 2 and 4 tons weight. Two cableways of 3-ton capacity each

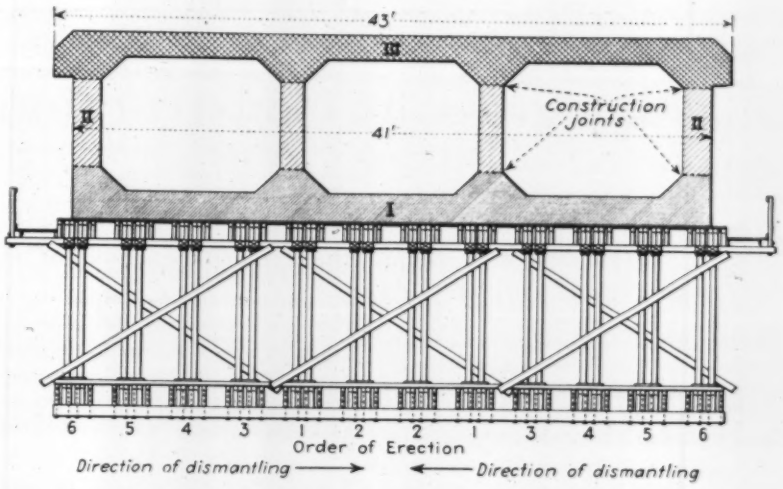


Fig. 3. Cross-section of arch ring and timber center showing order of erecting and taking down ribs of the arch center.

transported the pieces to their definite position. The erection began with two trusses, (No. 1, Fig. 3,) at the two abutments on auxiliary scaffolding with the aid of cable anchorages, (Fig. 2). Under the center of the span a wooden tower was erected, upon which the middle part of the two trusses was built forward to meet the two abutment sections. The closure of the first two trusses in the quarter-points took place with great accuracy.

After closure of these first two trusses large 42-ft. timbers were fastened across the lower chords. The other 10 trusses were successively erected on this hanging scaffolding. The first two trusses were closed March 5, 1938, the last truss, April 22, 1938. Only 14 men were employed, of which 6 men worked on the assembly of the trusses in the yard. After erection of all the trusses the timber arch was adjusted by hydraulic jacks in the crown. A test load was then applied consisting of a uniformly distributed load of 3,400 tons, which was put on the centering in the form of gravel-filled cement bags. The measured deflection at the crown was only 2¾ in., a very small value in comparison with the large span.

The bridge is being built by the Swiss federal railways. The use of the timber arch truss was conceived by Locher & Cie., Zürich, which firm holds also the contract for fabrication and erection. Contractors for the bridge itself are the four firms: Kastli, Berne; Locher & Cie., Zürich; Ramseier & Cie., Berne; Rieser & Cie., Berne.

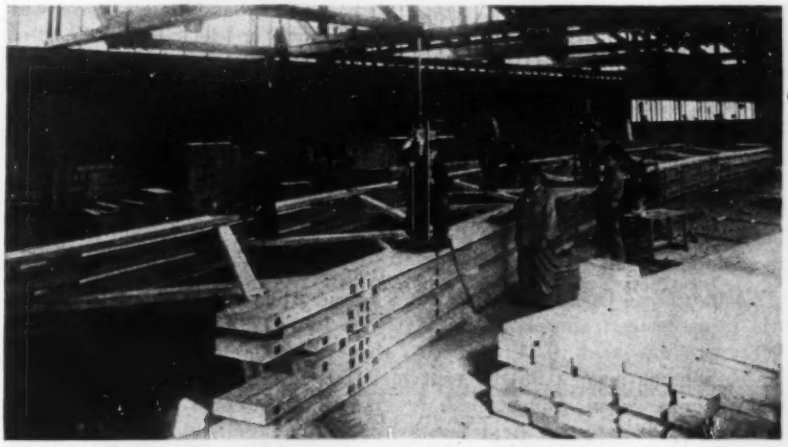


Fig. 4. Ribs for center framed in assembled position in the contractor's shop at the site of the bridge.

Progress in Construction Materials

Research and development work reported at the A.S.T.M. meeting includes completion of a unified specification for bridge and building steels, and investigations that add to knowledge of endurance, corrosion resistance, soils and timber

IMPORTANT CONTRIBUTIONS to knowledge of construction materials made in papers and committee reports before the American Society for Testing Materials two weeks ago are abstracted below, supplementing our news account of the meeting published last week (*ENR* July 6, p. 36). The new facts bear on engineering use of steel, concrete, timber and other materials.

In the structural field a leading item of interest is a new consolidated specification for bridge and building steels, covering a steel adapted to general use and another steel restricted to use in static structures; the specification is featured by a wide range of phosphorus content—from 0.4 to 0.10 per cent—but identical physical tests. In the field of concrete a study of modern lean concretes, result of present-day high-strength cements, is of outstanding importance. Light is thrown also on pavement failures due to the use of bad sand and gravel.

Fatigue studies bearing on the unexplained failure of the heat-treated bridge wire used at Mount Hope, and on as yet uncorrected weaknesses of car axles, represent further advance in the metals field. In soils, comparison of direct and triaxial shear tests showed that for practical purposes they give the same result. An interesting chapter is added to the history of the long-continued exposure tests of iron and steel sheets by a report on 22-year behavior of sheets exposed at Annapolis, which show no less than 8 sets of sheets out of 26 to have survived without a single failure.

One of the oddities reported was that studies of zinc corrosion show night-time corrosion to be fully one-half greater than daytime corrosion.

New Steel Specification

New standard specifications for steel for bridges and buildings, consolidating the former separate specifications for bridge steel and building steel, include the following provisions:

Process of manufacture—Openhearth or electric furnace steel unrestricted as to use. Acid bessemer steel restricted to sections $\frac{7}{16}$ in. or under in thickness intended for use in buildings and other structures subject to static loads only.

Composition—Openhearth or electric furnace steel: phosphorus max., 0.06 per cent acid, 0.04 per cent basic; sulphur max., 0.05 per cent; copper min., when copper steel is specified, 0.20 per cent. Acid bessemer steel, phosphorus min., 0.10 per cent; sulphur not specified; copper min., when copper steel is specified, 0.20 per cent.

Carbon is specified only for rolled base plates over 2 in. in thickness for bearing purposes. These are to be of openhearth or electric furnace steel containing 0.20 to 0.35 per cent carbon and subject to the other chemical requirements given above but not to physical tests.

Tensile tests—All material except rolled base plates over 2 in. thick, flat rolled steel $\frac{3}{16}$ in. or less in thickness, shapes less than 1 sq.in. in cross section, and bars less than ½ in. in thickness or diameter, as well as eyebar flats subjected to full-size tests, shall have: tensile strength, 60,000 to 72,000, minimum yield point 0.5 of the tensile strength but not less than 33,000, minimum elongation in 8 in., 1,500,000 divided by tensile strength or 22 per cent. Reductions in required elongation are made for material over ¾ in. and under $\frac{5}{16}$ in. thick.

When finished eyebars are not subjected to full-size tests, unannealed eyebar flats are to show a tensile strength of 67,000 to 82,000 with yield point not less than one-half the tensile strength or not less than 36,000, elongation in 8 in. 1,500,000 divided by tensile strength, and elongation in 2 in. 20 per cent minimum.

Bend Tests—Specimens shall bend cold through 180 deg. without cracking around pin of diameter equal to half the thickness of the specimen for material ¾ in. thick and under, equal to the diameter of the specimen for material ¾ to 1 in. thick, etc.

Surface Defects—Surface defects that do not affect the full utility of the pieces when found in structural shapes ⅜ in. or more in thickness may be ground out (when less than $\frac{1}{16}$ in. deep) or chipped and welded. —Reported by the COMMITTEE ON STEEL and approved by the society for immediate adoption as standard.

Twenty-Two-Year Rusting Tests

Exposure tests of uncoated corrugated black sheets of iron and steel were begun in October 1916, and the No. 22 gage specimens at Annapolis, Md. have not yet all failed. The latest inspection, made Oct. 10, 1938, covers the effect of 22 years exposure. Of 11 sets of openhearth steel sheets, 7 sets of openhearth iron sheets, 6 sets of bessemer steel sheets, and 2 sets of wrought-iron steel sheets, the entire series of 26 sets totaling 220 sheets, all sheets of 7 sets have failed, with average life per set ranging from 10.4 years to 19.2 years. Of the remaining 19 sets some sheets have failed and some survive in 2 sets of non-copper-bearing material and 9 sets of copper-bearing material. In

8 sets, all copper-bearing material, no sheets have yet failed.—COMMITTEE ON CORROSION OF IRON AND STEEL.

Rusting of Steel Wire

Two years' results of atmospheric corrosion tests on wire, seven-wire strand, barbed wire, chain-link and farm fence at eleven different locations are now available. The exposures include industrial, sea coast, and rural.

At Pittsburgh galvanized wire has rusted extensively, at Sandy Hook and at Bridgeport somewhat; no rusting has occurred at the other locations. Copper-coated wire has shown no rusting anywhere. All of the lead-covered specimens have "a rusted or rust-like appearance." Uncoated corrosion-resistant steel wire has shown no significant corrosion at any location. Some of the 12 to 14 per cent chromium wires have developed superficial yellow or rust discolorations, but the 18-8 wire has generally remained bright or metallic colored.

Strength tests showed a gain in strength in a number of cases. In the majority of cases the second set of tensile specimens removed from the test racks showed greater strength than the first set (19 out of 32 wires showed an average of 3 per cent gain of the second specimens as compared with the first). Strength loss during two years' exposure at Pittsburgh ranged from 18.5 per cent for wire of 14.5 gage to 5.7 per cent for 6 gage, in the copper-bearing specimens, and from 20 per cent for 14.5 gage wire to 7.2 per cent for 6 gage wire in the low-copper specimens.—COMMITTEE ON CORROSION OF IRON AND STEEL.

Stainless Steels in Service

The Chrysler Building has a spire and coping covered with stainless steel of 18 per cent chromium and 8 per cent nickel composition. This 18-8 has not been cleaned since it was installed in 1931. Although darkened by a film of soot and smoke the material is easily brightened by rubbing with pumice and whiting. There is no pitting; some minor etching can be detected with a magnifying glass.

On the Empire State Building the spandrels of 18-8 also exhibit a dark stain, which can be readily removed, revealing the original finish of the material. Slight etching in one location is believed to be due to contamination by dirt, cement and cinders during construction of the building.

The Philadelphia Savings Fund Society building uses 18-8 stainless steel for store fronts and marquees outdoors as well as for numerous indoor details. The exterior is cleaned every few days when the windows are washed; soap and water are used. No staining, rusting or pitting is visible at any point.

At Atlantic City four store fronts subjected to heavily salt-laden atmosphere utilize 18 per cent chromium and 18-8 stainless steel. Straight 18 per cent chromium discolors very quickly, so that the stainless steel is preferable. Where the stainless steel is cleaned regularly, it is in excellent condition. When it is not cleaned, pitting and rusting of minor character is noted.—COMMITTEE REPORT.

"Sensitive" Steels

Out of the necessity for finding an explanation for unusual steel failures, generally associated with cold work and impact, a test has been devised, known as the work-brittleness test. It involves a relatively new concept of sensitivity of a steel as the response of the metal to cold work, i.e., the degree to which it is made hard or brittle. Two steels identical in chemical composition and static physical properties may react very differently to cold-working. A steel greatly embrittled by cold work is considered a sensitive steel; one only slightly embrittled by the same amount of cold work is considered insensitive. The method of test finally adopted involves cold-working a tapered round specimen 10 in. long, 0.475 in. dia. at one end and 0.450 in. dia. at the other end, by drawing it through a 0.450-in. die. The resulting 11-in.-long specimen is then notched with standard Izod V-notches at 1.1-in. intervals and broken in impact; plotting the various values gives a work-embrittlement curve.—H. W. GRAHAM and H. K. WORK, *Jones & Laughlin Steel Corp., Pittsburgh.*

Discussion—In answer to a question by L. S. Moisseiff on how to specify against sensitivity in steels for structural purposes, Mr. Graham pointed out that most austenitic fine-grained steels are insensitive and that open-hearth is more insensitive than bessemer steels. He stated that manufacturing practices — particularly methods of deoxidation — cause differences in the sensitivity of steels.

Fatigue Tests of Wire

To explore certain unknowns in the problem of fatigue failure of suspension bridge wire at the University of Illinois, specimens of Mt. Hope bridge wire and of $\frac{3}{16}$ and $\frac{1}{8}$-in. cold-drawn steel rods were tested on three different types of endurance test machines. In two of these machines the original surface of the wire was exposed to the maximum stress, while in the third a machined and polished specimen was used. It was found that stretching the specimens by 0.10 per cent permanent tensile elongation in order to straighten them from coiled or curved conditions did not affect the endurance limits.

The rod specimens showed an endurance limit of 58,000 lb. when machined and polished, but only about 40,000 lb. when the original surface was exposed. The decrease due to surface effects thus was about 30 per cent. The heat-treated and galvanized bridge wire, however, showed a corresponding drop of 57 per cent, from 132,000 lb. per sq.in. for a machined and polished specimen to 57,000 lb. per sq.in. for specimens with the original galvanized surface.

A rotating-strut machine, in which a length of wire is rotated while deflected by buckling under endwise load, was found to be a satisfactory endurance test device.—C. P. WAMPLER and N. J. ALLEMAN, *University of Illinois.*

Endurance Testing Machines

Four endurance testing machines capable of testing full sized structural parts have been installed in the New Kensington Laboratory of the Aluminum Company of America. Three of the machines are for testing joints, while one is for columns and beams. The former have a capacity up to 16x30 in., while the latter can test for columns up to 18 in. square by 6 ft. 8 in. long and beams 6x6 in. in section by 7 ft. span. Speeds range from 210 to 500 cycles per minute. Loads (up to 50,000 lb. capacity) are applied by long loading levers pivoted on plate fulcrums and reciprocated by eccentrics.

The first of the machines has been in service for four years, but no results are yet available except a typical

endurance curve for a riveted butt joint. This curve (stress plotted as ordinate and cycles as abscissa) is very similar to the endurance curve of plain aluminum or duralumin specimens. It is reported that the full-size tests show marked consistency.—R. L. TEMPLIN, *Aluminum Company of America, New Kensington, Pa.*

Lean Concrete

During 1938, tests on 10,000 specimens were carried out at the research laboratory of the Lone Star Cement Corp. at Hudson, N. Y., to study the properties of lean concrete mixes. One portland cement ground to three different finenesses and one high-early-strength portland cement ground to two finenesses were used. In addition to the study of plain concrete mixes, the effect of adding an inert admixture of ground limestone to the lean mixes was investigated. Cement content ranged from 2 to 6 bags per cubic yard. Enough filler was added to each mix containing less than 5 bags of cement to make the sum of the absolute volumes of cement and admixture equal to that of five bags of cement. The tests were made on various mixes of gravel concrete using 2-in. and 6-in. slumps.

One general conclusion is that the large amount of water required for the lean mixes affects other physical properties adversely. With modern cements, if strength alone were considered, the cement content for a 2000-lb. concrete could be reduced to less than 4 bags per cu.yd., but due to the high water ratio of such mixes the resulting concrete would be of low durability. Therefore, in order to assure adequate durability of concrete exposed to weathering the water content should be specified.

Other conclusions were as follows:

Addition of filler to mixes containing less than 4 bags of cement improved the compressive strength, while the addition of filler to a 5-bag mix lowered the compressive strength.

Increased cement fineness improved workability but was ineffective in mixes containing less than 3½ bags of cement. Increased cement fineness was accompanied by an increase in compressive strength at early ages up to 7 days, but at 28 days and 3 months fineness was less effective.

Water-cured specimens gained steadily in strength up to 3 months while air-cured specimens gained practically no strength after 28 days. High-early-strength cement produced the least difference between air-cured and moist-cured strength, indicating greater curing efficiency for this type of cement.

Durability of concrete as expressed by resistance to freezing and thawing decreased as cement content decreased. Reducing cement from 5 to 4 bags decreased durability by about 43 per cent while increasing cement from 5 to 6 bags improved durability about 64 per cent. For mixes of the same cement content, the finer cements produced concrete of somewhat greater durability. Concretes of the same water-ratio had about the same durability regardless of cement fineness or 28-day compressive strength. Water-cement ratio was the governing factor for durability.—ERNST GRUENWALD *Incor Division, Lone Star Cement Corp., New York, N. Y.*

Permeability of Concrete

Permeability of concrete implies fluid passage in (1) liquid form, (2) as capillary evaporation moisture, and (3) by water-vapor movement. A study now in progress to correlate these actions includes some tests of the same concrete tested for water passage under all three conditions, tests of identical specimens for capillarity at low heads, and investigation of a proposed method to compare high-head liquid flow to capillarity.

The new information secured from the tests is that capillary movement of water through concrete may be of greater magnitude than that of free liquids at ordinary heads. For that reason permeability tests which operate at heads less than 10 ft. measure mostly capillarity. The low-head tests show concretes containing water-repellent materials to be more resistant to capillarity than standard portland cements because their surface tension characteristics have been altered. Such tests, however, do not necessarily measure the ability of these concretes to resist the passage of liquid water.

The tests indicated that high-strength cement increases watertightness in all forms of flow measurements (with heads less than 100 ft.) in proportion to the amount by which it increases the compressive strength of the concrete. In the average usable concrete under average evaporation conditions, capillary movement of water far exceeds the amount of water caused to progress through the concrete by an applied static head.—W. M. DUNAGAN, *Associate Professor, Theoretical and Applied Mechanics, Iowa State College.*

Aggregates and Pavement Failures

An investigation made to determine the cause of pavement failures in Kentucky, which take the form of progressive scaling followed by disintegration of the concrete, included a concrete pavement condition survey and laboratory tests on the aggregates. The investigation indicated that failure and disintegration of concrete pavement throughout the western part of the state resulted from the use of chert gravel obtained from the Tennessee and Cumberland rivers and that the fine aggregate did not contribute to the failure. The investigation also indicated that crushed sandstone resulted in satisfactory pavement when used with Ohio River sand, whereas when used with sand manufactured from sandstone it resulted in unsatisfactory pavement. It was concluded that, with present methods of pavement construction, chert gravel will not produce durable pavement; and that chert gravel may be eliminated by two specifications: (a) coarse aggregate shall not show an absorption greater than 3 per cent when subjected to A.S.T.M. standard test C95-36, and, (b) concrete shall not show a reduction in flexural strength greater than 30 per cent when subjected to 40 cycles of freezing and thawing in the presence of water.—CURTIS CANTRILL and LOUIS CAMPBELL, *Kentucky Department of Highways.*

Effect of Acid on Concrete

An investigation to determine the resistance of concrete to the corrosive action present in farm silos from acetic and lactic acids developed a test method that may have wider applicability in studying the effect of acids on concrete. Concrete silo staves and test bars were used as specimens. The greatest difference in resistance of the nine portland cements tested was found to be as 1.0 is to 1.6. This difference is small compared to that of 1 to 10, which has been found in connection with specimens exposed to solutions of sodium and magnesium sulphate, but is still large enough to be significant. The stand-

ard portland cements that made the best showing generally were ones that have been found to be resistant to sulphate. The two high-early-strength cements included in the group gave results almost identical with those of their companion standard portland cement.—DALTON G. MILLER, CHARLES F. ROGERS and PHILIP W. MANSON, *University of Minnesota.*

Shear Testing of Soils

Comparison of shearing tests of soil by the ordinary translatory or direct shear device, the triaxial compression machine, and a torsional apparatus showed that the torsional shear test has no advantage over the others for determining maximum shearing strength. However, it is believed to be the best method, and in the case of many clays the only method, for determining the beginning of slow plastic flow before failure, the velocity of this flow, the decrease of shearing resistance after failure, and the relation between this decrease and the velocity of plastic flow.—M. J. HVORSLEV, *Harvard University.*

Comparative tests of several sands in a direct shear machine and the triaxial compression apparatus in the soils laboratory of Massachusetts Institute of Technology showed close agreement. The average difference in maximum friction angle found by the two methods was only one or two degrees, and remarkably close agreement was found between the shapes of stress-strain curves plotted from the two forms of apparatus after adjusting the values of strains by suitable change of scale. The direct shear method gave consistently larger critical void ratios, but by only a few per cent.—PROF. DONALD W. TAYLOR, *Massachusetts Institute of Technology.*

Reaction Between Iron and Water

The corrosion of iron by water is subject to the influence of substances in solution, notably oxygen, carbon dioxide and salts, and there is good agreement as to their quantitative effects. However, the fundamental reaction that occurs when iron is placed in pure water, free of all substances except an inert gas, has received little attention. To study this fundamental reaction and determine the pH value and dissolved iron concentration, experiments were conducted using water free of undesirable dissolved gases such as oxygen and carbon dioxide and iron vessels in which hydrogen was kept above the liquid. Iron bars cut from ¼-in. stock were immersed in the water for various periods. The pH value of the water from a container opened after 20 days was 8.2 and the same value was obtained from containers held 120 days. This compares with 9.4 to 9.6 pH obtained by earlier investigators using apparatus of somewhat cruder form than in these tests. The solutions also were found to contain iron in the ferrous form. Saturating the liquid from the vessels with oxygen reduced the pH value to 6.6, indicating that the ferrous iron was the only contributing factor to the increase in pH value.

In the bottom of the vessels was found a black powder determined to be the magnetic oxide, Fe_3O_4. It has been generally believed that ferrous hydroxide is the end product of the iron-water reaction, but from these tests it is concluded that in the oxidation process the initially formed ferrous hydroxide decomposes the water to form magnetite as the final solid product.—RICHARD C. COREY and THOMAS J. FINNEGAN, *chemists, Consolidated Edison Co., New York.*

Knot Size in Timber

Limiting knot sizes are specified in current timber standards, but application of these limits is often difficult because the knot often is hard to distinguish from the crossgrain surrounding it. Difference in color sometimes merely marks out the heartwood of the knot from sapwood and body wood. In this case there are two ways of determining the limits of the knot:

First, the rings on the top of a limb are usually narrower than those on the bottom and narrower than those in the body of the tree just above; by tracing the growth rings at the top of the knot around to the bottom the knot can be outlined. Where the knot is cut at an angle the identification point may be found to one side of the top. Second, checks in the face of a knot running to the sides never run beyond the knot without an abrupt change in direction.

Oaks are particularly troublesome. At the top of the oak knot the growth rings usually change abruptly to burly irregular grain, often with bark pockets; this point marks the division of the knot from the body wood above. Radial checking in the oak knot is often very prominent, and checks that run to the side never run beyond the limit of the knot without an abrupt change of direction.—JOHN A. NEWLIN, *Forest Products Laboratory, Madison, Wis.*

Fatigue Strength of Axles

Endurance or fatigue tests of full-sized steel car axles, 5⅞ in. minimum diameter at center of body, in comparison with small model axles and with still smaller fatigue test specimens, showed a much lower endurance limit for the large axles. The axles were forged and smooth turned. Model axles 1½ in. in diameter similar in shape to the large axles were turned from 2¼ in. hot-rolled round steel from the same piece. Small fatigue test specimens 0.3 in. in diameter, turned and polished, were made from pieces cut from the large axles. The respective endurance limits were 33,000 lb. per sq.in. for the small specimens, 28,000 lb. for the 1½-in. axles, and 17,500 for the full-sized axles.

The full-sized results, however, showed large scatter. Only eight axles out of 31 broke in the tests, and the axles that did not fracture at 10 to 50 million cycles indicated an endurance limit of about 25,000 lb. per sq.in. Some of the axles were cold rolled on the surface, and these did not break in the endurance test even at stresses up to 29,000 lb. repeated 70 million cycles. The causes that were responsible for the low endurance of the eight axles were not found.—O. J. HORGER and H. R. NEIFERT, *Timken Roller Bearing Co., Canton, Ohio.*

Sonic Modulus of Elasticity

A new sonic method for determining the modulus of elasticity of building materials utilizes the measurement of the fundamental frequency of a rectangular prism of the material by an apparatus consisting of a variable-speed oscillator which actuates a driver, or hammer, bearing directly on the sample, which may or may not be under stress. The resulting vibrations in the sample are picked up by a high-gain amplifier and recorded on an oscillograph. By varying the oscillations the fundamental frequency of the sample is determined when a maximum amplitude is obtained on the oscillograph. For any particular mode of vibration, there is a simple relationship involving the frequency, dimensions,

and density of the specimen from which Young's modulus can be calculated. The principal advantage of the method is its simplicity.—LEONARD OBERT, *U. S. Bureau of Mines.*

"Adhesivity" of Asphalts

In order to evaluate the "adhesivity" of an asphalt, that is its resistance to being displaced from the aggregate surface in the presence of water, laboratory tests of various kinds have been employed. Recently the circular track machine was used in a series of tests to determine a correlation between laboratory results and actual traffic effects, and from this investigation it was indicated that adhesivity may be improved by:

(a) Increasing the alkaline character of the surfaces of the acidic aggregates by either coating or treating the surface with portland cement, lime, or analogous materials.

(b) Modifying the surface properties of the aggregate through treatment with heavy metal salts.

(c) Modifying the properties of the asphalts by the addition of various activating agents such as the fatty acids, complex or organic compounds, heavy metal soaps, etc.

(d) Modifying both the surface properties of the aggregate by special treatments and the properties of the asphalt by the addition of wetting agents.—AUGUST HOLMES, *Standard Oil Development Co.*

Road Rollers and Aggregates

To determine the degradation of aggregates under road rollers, six crushed limestones, four crushed gravels, four uncrushed gravels and one blast furnace slag were tested on a rigid base and on a flexible base. The rigid base was a 6-in. concrete slab laid on 6 in. of compacted pit-run gravel, while the flexible base was a 2½-in. bituminous mat placed on 9 in. of compacted pit-run gravel. A 10-ton Austin-Western 3-wheel roller, and a 5-ton Huber 3-wheel roller were used.

Results included the following: An average of 2.3 times as much degradation occurred on the rigid base as on the flexible base; rear rollers did more work than front rollers; degradation increased proportionately with the number of trips for both rollers on the rigid base, although with the heavier roller on the flexible base a maximum was reached in from two to five trips. The order of rating the aggregates from these tests is approximately the same as that secured from Los Angeles rattler tests; a fairly good correlation was found to exist between the loss after 100 revolutions in the rattler and after seven round trips of a 10-ton roller on a rigid base.—TILTON E. SHELBURNE, *Purdue University.*

Prestressed Beams

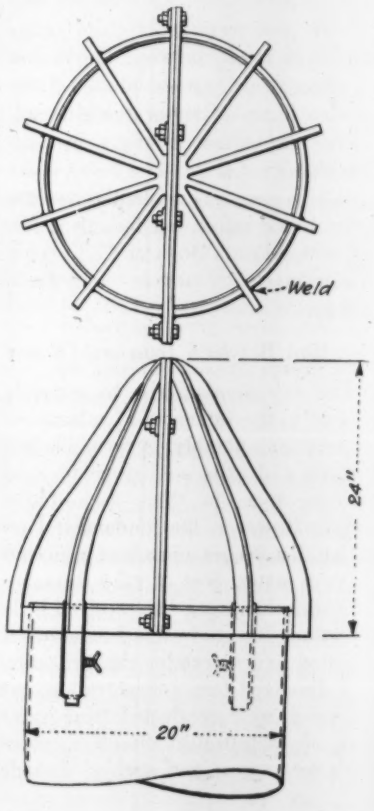
To study the principles involved in prestressing steel reinforced beams, a model beam of Bakelite under center loading was subjected to photoelastic analysis. The total prestress on a beam was shown to be equal to the total loading stress when the compression in the bottom fibre is just neutralized. At that stage the directions of principal stresses are displaced 10 and 80 deg. from the vertical and horizontal, respectively, so that the principal shears will then make angles of 35 and 55 deg. on the opposite side of the vertical. Advantages of prestressing reinforced beams include: immediate use of steel as soon as load is applied; this results from the fact that there is no tension in the masonry material which must first be overcome; (2) more effective use of the masonry material so that a smaller section is needed; and (3) a noteworthy increase in stiffness, which may be due to the difference between the modulus of elasticity in compression and tension. To make the most economical use of reinforced steel, the prestress should be about two-thirds the yield point.—F. O. ANDEREGG, *Consultant,* and ROYAL WELLER and B. FRIED, *Ohio State University.*

Protective Tip for Ventilating Pipes

A STEEL TIP, or frame, for protecting the end of tunnel ventilating pipes from damage by rock fragments thrown from the face in blasting, is being used on the Stanislaus tunnel in California. Protected by this device, 20-in. ventilating pipes are run to within 40 ft. of the face and are left in place during blasting, without danger of damage from flying rock fragments. With the pipe thus brought closer to the face, better ventilation is obtained and the operation of exhausting immediately after a blast is more effective.

The tip consists of two halves each made up of five straps of ½x2-in. bars welded together as shown in the accompanying sketch. The halves are bolted together and the assembly is then slipped over the end of the pipe and held in place by a pair of light wires passed around fins raised in the pipe metal for this purpose.

The Stanislaus tunnel job is being done by company forces under the direction of O. W. Peterson, engineer of general construction, Pacific Gas and Electric Co.; J. E. Cooney is project superintendent, and Harry F. Scott is tunnel superintendent.



Simple device for protecting end of ventilating pipe from rock fragments blasted from tunnel face.

Thin-Shelled Wood Dome For World's Fair Building

H. ALDEN FOSTER
Formerly Chief of Engineering Design
New York World's Fair 1939, Inc.

Contents in Brief—Light weight without sacrificing rigidity was the goal in construction of the dome of the Heinz Co. Building at the New York World's Fair. This feature was obtained by use of a steel-ring and wood-rafter framework covered inside and out with diagonally-laid sheathing.

UNUSUAL FRAMING is a feature of the "beehive" dome of the Heinz Co. exhibit building at the New York World's Fair. Rising 68 ft. from the 23-ft.-high steel framework of the lower part of the building, the dome structure consists of horizontal steel pipe rings spread by wood rafters, to which is attached wood sheathing in a "herringbone" pattern. Stucco forms the exterior finish.

This structural layout is similar to that used for construction centering on the thin-shelled concrete dome of the Hayden Planetarium in New York City (*ENR*, July 25, 1935, p. 108). However, as far as the writer knows, this is the first time such a design has been used for the main supporting structure of a dome.

The design consists of a series of wooden rafters 3 in. thick located in meridian planes. The ends of these rafters bear against 3-in. iron pipes which form the "parallels of latitude." The rafters are notched at each end, as shown in Fig. 1, and press against the pipes, but are not fastened to them; they are shaped on both exterior and interior edge to conform to the vertical curvature of the dome. The rafters are sheathed, on both faces, with $\frac{25}{32}$-in. x $5\frac{5}{8}$-in. square-edged lumber, laid with $\frac{1}{4}$-in. open joints.

In erecting the dome, the lowest pipe ring was first put in place, being supported on the steel structure of the building by cast steel saddles at about 39-in. centers. When the ring was adjusted to correct elevation and diameter, sleeve splices in the ring were welded and the saddles were welded to the pipe and to the supports.

The second pipe ring was then assembled in place, adjusted for diameter, and spliced. The ring was held in place by scaffolding about $\frac{3}{4}$ in. below its theoretical position. The lowest tier of rafters was then installed by slipping the notched ends over the two pipe rings. This procedure raised the second pipe ring to its theoretical elevation, and transferred its weight to the rafters, though it was temporarily braced to keep it in correct position.

The third pipe ring was next assembled as described above, and the second tier of rafters placed. Installation of the exterior sheathing then commenced, the sheathing being applied diagonally in a "herringbone" design, as shown in Fig. 2. This procedure was continued for successive pipe rings and tiers of rafters.

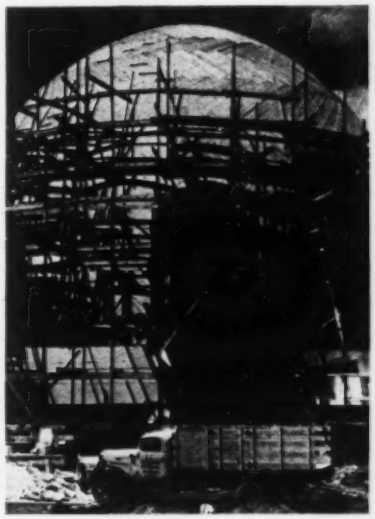


Fig. 2. View of the dome after sheathing had been applied in a "herringbone" pattern.

Not more than three tiers of rafters were allowed to be erected in advance of the exterior sheathing.

The inner sheathing was applied in a manner similar to the exterior, and approximately at right angles to the latter. It was carried up with the exterior sheathing and kept within one tier of the exterior. The pipe rings were securely braced in their proper position until the interior sheathing was installed.

Looped rods, as shown in Fig. 1, were installed, 16 to a tier, in the lower four tiers, to furnish a positive

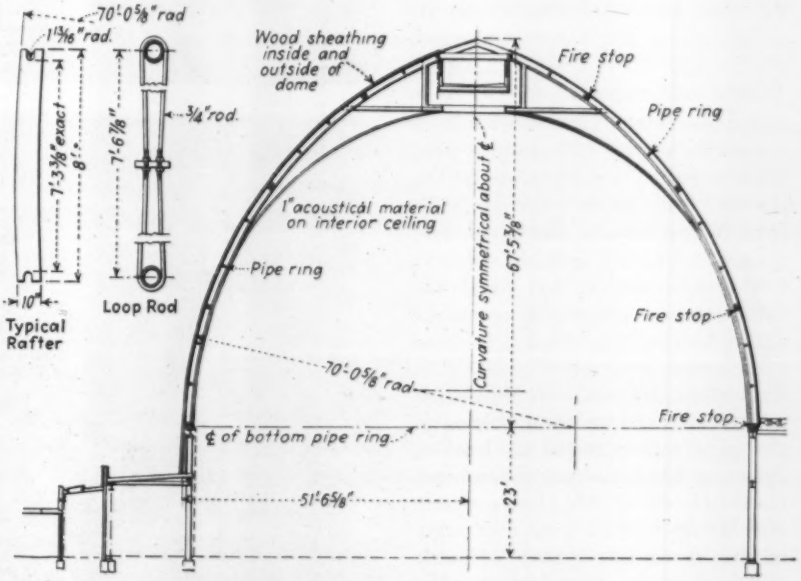


Fig. 1. Cross-section through the Heinz Co. World's Fair building. Details at upper left show timber spreader rafters and rod ties for lower four tiers of rafters and pipe rings.

anchorage of the dome framework to the supporting structure. The resulting dome structure is quite rigid. It is relatively light in weight and caused very little trouble in fabrication and erection.

The exterior surface received a waterproofing coat consisting of two layers of felt with a layer of cold mastic between. The final finish is a one-inch coat of cement and lime stucco bound with 2x2-in. mesh wire lath.

The interior finish of the dome is acoustical tile. The lower portion is attached directly to the interior sheathing, but in the upper portion of the dome, the ceiling is suspended to obtain a spherical shape.

The structural plans for all buildings constructed by the World's Fair Corp. were prepared by the engineering staff under John P. Hogan, chief engineer and director of construction, and L. B. Roberts, assistant chief engineer. The writer had direct charge of engineering design. The stability of the dome described herein was reviewed by Purdy & Henderson, consulting engineers.

High Voltage Power Cables Go Aboard a Suction Dredge

MEANS of getting electric power aboard a large dredge, well away from shore, have been worked out in a safe and convenient manner for the *S.G. Hindes*, a suction dredge that has been filling in the new Alameda Naval Air Base on San Francisco Bay. This dredge sometimes uses 4,000 hp on the pump motor and has a total demand of about 5,500 hp.

To bring this much power through salt water while the dredge is swinging its cutter head and walking ahead on its spuds, presented a problem that was solved by the use of a cable barge on which is a reel carrying some 2,000 ft. of 11,000-volt armored cable (250,000 circ.mil.) The end of the cable attached to the reel terminates in three slip rings on the end of the shaft so that the connection remains undisturbed as the cable is reeled in and out. The barge is lashed behind the dredge with enough cable slack to permit free movement of the dredge. This arrangement is facilitated by the devices illustrated, one at each end of the barge.

The large sheave, over which the cable passes as it comes up out of the water, was built up from 6-in. pipe bent into a circle of 4-ft. diameter. Circumferential cuts were then made with a torch and the outer portion of the pipe was removed to leave a sheave in which the groove is a semicircle. On either side of this groove circular steel plates ¼ in. thick were welded to connect groove and axle about which the sheave rotates. The axle is a 3-in. pin, carried by ½-in. steel plates from pin to shackle that suspends the sheave. This arrangement was not expensive and had the advantage of being much lighter than ready-made sheaves.

Between cable barge and dredge the cable required support at a height that could be varied readily as conditions changed. This need was met by a slightly curved shoe support slung from a convenient point on the dredge rigging, giving the necessary freedom as the dredge swings.

The devices were developed by the San Francisco Bridge Co., contractor for the dredged fill at the new air base.

An inexpensive sheave (top) brings an 11,000-volt cable on to the barge safely. The sling support shown in the lower picture keeps the cable out of the way as the relative position of dredge and cable barge changes.

Intercepting Devices For Sewers

ALFRED WICKESBERG
City Engineer, Appleton, Wis.

***Contents in Brief**—Methods are given for designing and building two types of intercepting devices for use when intercepting sewers are to be added to an existing combined sanitary and stormwater sewer system.*

SEWER SYSTEMS of the past were designed on the simple principle of directing sewage to the nearest watercourse. When intercepting sewers are finally built to convey sewage to a single point of discharge they must be provided with devices which will direct the dry-weather flow from existing sewers into the interceptor, as well as shunt excess storm flows to the watercourse. It is the purpose of this article to describe the design and construction of two types of intercepting devices—the diversion dam type, and the leaping weir chamber.

In either type, the first problem is to determine the actual sewage flow from the tributary area, either by field observations or by the usual rational methods. Then the hydraulics of the sewer must be determined by field observations at the point of interception. The size of the sewer, and the depth and velocity of flow for the calculated amount to be intercepted are essential data.

What device to use

If field surveys indicate that there is sufficient fall between the existing sewer and the interceptor, a leaping weir chamber is desirable. In some cases this chamber can be built directly over the point of intersection of the two sewers. In other cases it may be necessary to place the chamber upstream for some distance and run a short connection to the interceptor. The advantages of the leaping weir chamber are its cheapness, ease of adjustment, and simplicity of construction. Another point in its favor is that under storm or surcharged conditions, it will shunt the excess flow with greater certainty.

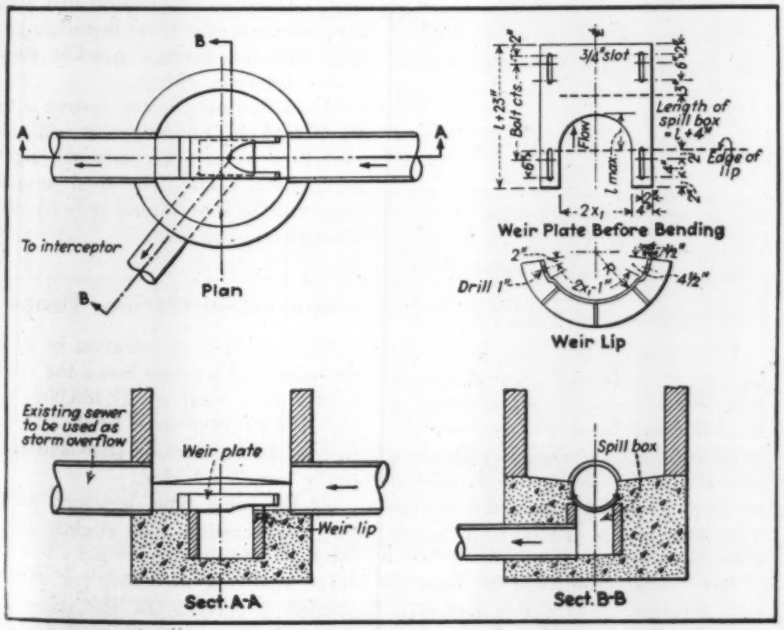


Fig. 1. Leaping weir intercepting chamber and details of weir plate.

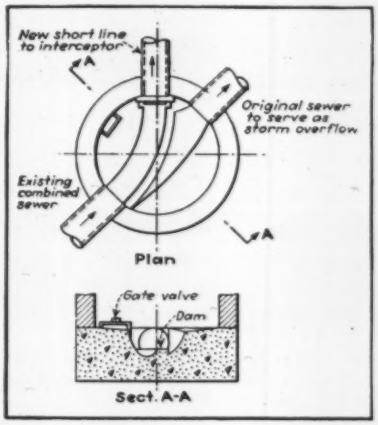


Fig. 2. Diversion dam type of intercepting chamber.

In sewers where fall is at a premium, the diversion dam type of chamber is preferred. The height of the dam is made equal to the depth of flow in the sewer when it is discharging its calculated amount. Anything in excess of this flow, therefore, will spill over the dam and discharge through the storm overflow. Because of uncertainties of storm flow, involving probable surcharged conditions, it is desirable to put a gate valve on the sanitary flow outlet. A cheaper means, however, of accomplishing the same purpose, is to install an adjustable aluminum orifice plate bolted to the chamber wall.

Construction of the dam type chamber is quite simple. (Fig. 2). The upper half of a five foot length of pipe is first removed, and a flume of 20-gage sheet metal is securely fitted with clamps and calked. The remainder of the pipe is then removed, the concrete bottom is poured and the gate set in place. Later, when the system is ready to receive sewage, the flume is removed and a temporary dam of clay is so placed that sewage can be diverted into the interceptor while the mason constructs the permanent dam in the dry. It is important that the bottom be kept smooth and free from any projections which might catch rags or other

Fig. 3. Looking down into a manhole housing a leaping weir intercepting device. During storms the excess flow leaps over the opening and passes into the overflow sewer.

debris. Adjustment of the gate valve or orifice can be determined only by field observations.

Leaping weir design

The functioning of the leaping weir is based upon simple hydraulic principles. For example, let it be assumed that h is the depth of flow of the sewage for the quantity to be intercepted, and v is its velocity. Then, the maximum length of opening should be such that a particle floating on the surface will fall the vertical distance h in just the time that it will flow along the sewer the distance l at the velocity of v. The derivation of the design formulas, and the steps involved in designing a plate, are as follows:

When

$t =$ time in seconds.

$l =$ horizontal distance in feet from upstream to downstream edges of weir at any point.

$x =$ horizontal distance in feet from center line of sewer to point where surface of falling stream cuts side of sewer.

$x_1 =$ arc distance, in feet, for any horizontal distance, x, x_1 is used for weir layout on flat plate, which is afterward bent to radius of sewer.

$d_1 =$ depth of flow in feet in sewer to be intercepted.

$v =$ velocity of flow in feet per second in existing sewer at interception rate.

$\theta =$ angle subtended at center of sewer by arc x_1.

For max. l ($\Theta = 0$)

$$t = \sqrt{\frac{2}{g} d_1} = \sqrt{.062\, d_1}$$

Let $.062\, d_1 = A$

Then, max. $l = v\sqrt{A}$ in ft.

For other values of l ($\Theta > 0$)

$d = d_1 - (R - R\cos\Theta) = d_1 - R\,\text{versin}\,\Theta$

$$l = v\sqrt{\frac{2}{g}(d_1 - R\,\text{versin}\,\Theta)} = v\sqrt{A - \frac{2}{g} R\,\text{versin}\,\Theta}$$

Let $\frac{2}{g} R = .062\, R = B$

Then $l = v\sqrt{A - B\,\text{versin}\,\Theta}$

The angles Θ are determined from arbitrary values of x. For max. x ($l = 0$)

$$\text{Max. } x = \sqrt{R^2 - (R - d_1)^2} = \sqrt{d_1 (D - d_1)} \text{ all in ft.}$$

For laying out the flat plate

$$x_1 = \frac{\pi R \Theta}{180} = .0175\, R\, \Theta$$

Let $.0175\, R = C$. Then $x_1 = C\,\Theta$

Theoretically, the weir plate can be correct only for one discharge rate. Therefore, it is well to permit a 2-in. decrease and a 4-in. increase from the designed capacity. The box into which the sewage spills should be long enough to catch the sewage when the plate is opened to its maximum position.

The construction of the leaping weir chamber calls for a combination of ingenuity and craftsmanship. First, the existing sewer must be accurately cut for the inside diameter of the chamber, and a flume of 24-gage sheet metal is then immediately inserted to carry the flow. The leaping weir plate and lip should first be bolted tightly to the bottom of the flume in its minimum position before the flume is inserted in the sewer. The bottom of the chamber can then be poured to the level of the invert of the sanitary connection to the interceptor, and on the following day the mason can build the spill box of brick and pour the remainder of the concrete. The flume has the triple duty of temporarily carrying the sewage flow, holding the weir plate and lip, and acting as a form.

In building the brick box, the mason should work on the side away from the sanitary outlet, and carefully point all joints so that no projections occur. A small strip of belting or other filler should be fastened to the flume at the downstream end of the weir plate so that a depression will remain to permit lengthening of the weir. The bolt slots should also be filled with clay. The plate and flume should be well coated with paraffin so that the concrete surface will be smooth. Some trouble has been experienced with the bottoms of the spill boxes eroding after a few years' use, so it is very important to secure the best concrete job possible.

Aluminum can be used to good advantage on metal work in intercepting chambers. Aluminum or brass bolts and nuts should be treated with care, however, for these materials are soft and the threads quickly strip with careless handling.

When the intercepting system is to be placed in operation, it will be necessary to remove only the light sheet metal flume. The final adjustment can be determined only by observation in the field.

• • •

Auto Registration Drops

Motor vehicle registration in 1938 decreased 0.7 per cent below the 1937 figures to a total of 29,486,000, of which 4,224,000 were trucks. These figures do not include state and federally owned vehicles.

At the same time, however, gasoline consumption rose slightly to a total of 19,610,000,000 gal.; an average state tax of 3.96c. per gallon yielded a revenue to the states of $756,853,000.

Rumination On Pavement Joints

H. J. GILKEY

Head, Department of Theoretical and Applied Mechanics
Iowa State College, Ames, Ia.

Contents in Brief—A well-known engineer takes an excursion into highway design fields to condemn doweled joints and indicate a construction that is mechanically logical.

IT IS pretty commonly agreed that concrete pavements should have joints, and that they should be capable of transferring load. Many kinds of load transferring joints have been devised but, in general, the doweled joint continues to be used in spite of an increasing recognition that it has serious fundamental defects as a device for distributing transverse loads. Fig. 1 illustrates some of these defects.

Weaknesses not shown are: The exuded filler, adding more to the impact load that comes on the slab, perhaps, than to actual riding discomfort; the lack of water-tightness, which enables the subgrade to be softened directly under the edges of the slabs where support is most needed; the tendency to fill up with dirt when open, thus limiting the joint's capacity to accommodate expansion. One end of a dowel must either be coated or encased in a sleeve and even the small added amount of movement required to bring such a dowel into bearing, greatly reduces the support that it will develop. In addition to these disadvantages, the simple dowel joint is always a construction nuisance.

While the writer's field of technical endeavor is not primarily that of highway design, he has been mildly irked that year after year his brother engineers of the highway field should be content to build into their highways so imperfect a device as the crude but common doweled joint.

A suggested improvement

As a result of such reflections, the writer submits the joint of Fig. 2 as a first approximation to something that should overcome most of the glaring deficiencies of the doweled joint. To the best of his knowledge it is new and totally untried. If the thing is good it will have to stand up under traffic and the writer isn't even tempted to make a laboratory test on it until and unless it proves itself to have practical possibilities. The apparent advantages of the joint may be summarized as follows:

1. It utilizes for transfer of load by shear the full depth of the slab and there is vertical support at every point along the joint.

2. There can be no exuded filler or filling up of the joint with dust and grit from above or with the subgrade material which oozes up from below.

3. The joint would be virtually waterproof and could easily be made totally so.

4. There can be no jog or impact as wheel loads pass from one slab to the other and the added stiffness decreases the amplitude of deflection, thereby greatly increasing resistance to fatigue as well as contributing to smooth riding and freedom from impact.

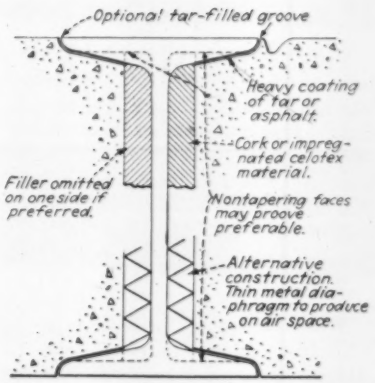

Optional tar-filled groove
Heavy coating of tar or asphalt
Cork or impregnated celotex material.
Filler omitted on one side if preferred.
Nontapering faces may proove preferable.
Alternative construction. Thin metal diaphragm to produce an air space.

Fig. 2. An I-beam type joint which provides for expansion, load transfer and sustained alignment.

Some of the possible drawbacks and their possible remedies are:

1. If standard-weight I-beams are used, the cost may approach that of some of the better of the patented joints. The answer is that if the idea proves sound, I-beams probably wouldn't be used but special light-weight sections would be rolled for this purpose at a much lower metal content and cost.

2. Perhaps the flange faces should be made to resemble the H-beam, that is, parallel instead of tapered on the inside. The taper of the I-beam flanges may possibly promote looseness when the pavement contracts and wedging when it swells.

3. The joint as shown may be more elaborate than necessary since there is probably no need of providing for expansion on both sides of the web. Thus simplified, there would be both a reduction in cost and added firmness of embedment.

A trial will doubtless expose other bugs but the writer can visualize nothing likely to prove so disqualifying or insurmountable as to brand this joint inferior to the makeshifts now so generally current.

He hopes that this article may stimulate some few highway departments to try out the joint this season and that in doing so they will, for the present, disregard considerations of relative cost, and work only toward securing data upon relative excellence. If the thing is found to be good, it will then be soon enough to investigate its economic feasibility in comparison with the performances and costs of alternate designs.

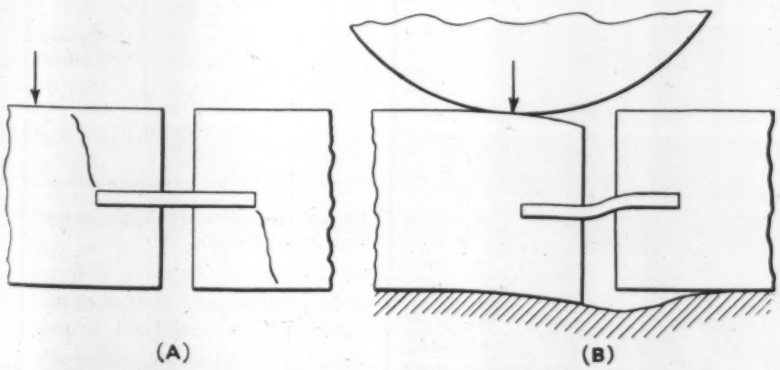


Fig. 1. Why dowel joints are mechanical failures. A. Never more than half the depth of the slab is available to resist shear and diagonal tension; stresses are repeated and reversed at each passage of a load. B. Whipping action takes place due to flexibility from poor load transfer and lack of support from beaten down subgrade; large bending and impact stresses develop from misalignment under load.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Coal Mix Seal Coat

W. R. MACATEE
District Engineer
Asphalt Institute, Washington, D. C.

Where cold-mix liquefier types of asphaltic concrete surfaces are installed, it is good practice to seal such surfaces with precoated fine aggregate, spreading it uniformly on the surface after initial rolling and before final compaction. The fine aggregate should pass the No. 10 sieve with 60 per cent or more retained on the No. 50 sieve, and contain about 2 per cent of suitable asphalt material to precoat it. After the fine, precoated aggregate has been spread at the rate of 4 to 7 lb. per sq.yd. of surface, it should be subjected to a thorough rolling. Such seals serve to prevent porous surfaces, and likewise provide excellent skid-resistance.

. . .

Fences Prevent Road Washouts

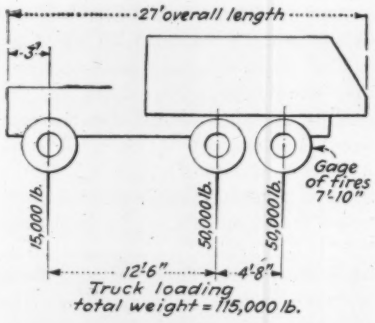
Where highway fills skirt California streams subject to heavy floods, metal fences along the toe of the slopes are effective in preventing washouts. Various types have been studied by the California Division of Highways and one which has given protection even under extreme conditions is shown. This fence is made of a double row of T-rail posts and wire mesh; the rows are 5 ft. apart, the rails are spaced 12 ft. on centers and wire crossties are used. Ordinarily 60-lb. rails 30 ft. long, driven to 20 or 25-ft. penetration, are used. The rock and brush filler is enclosed in baskets to permit settlement to conform to scour. After the extremely heavy floods of the 1937–38 season, it was decided that the tops of the rail posts should be tied to anchors embedded in the fill.

This slope protection of T-rails and wire mesh, on the outer edge of a bend in the stream, held despite overtopping.

. . .

Motor Truck Weights Govern Bridge Design

The dump truck bodies specially built for use of Pacific Constructors, Inc., contractors on Shasta Dam, have capacities of 25 cu. yd. (24 cu. yd. at "water level") and a full pay load weighs about 40 tons. With the truck body weight at 20 tons, this brings gross load on the ten tires to 60 tons.



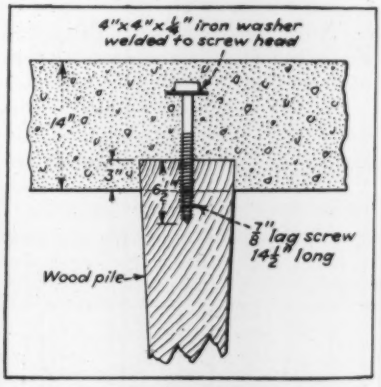
Distribution of wheel loads of trucks used at Shasta Dam.

In designing the 115-ft. steel girder span of the contractors' bridge across the Sacramento River it was found that a string of these 60-ton loads would produce stresses exceeding those from construction railroad trains. The bridge carries a single track railroad and a one-lane highway which is laid in (not alongside) the track. Thus in figuring stresses motor truck loads governed.

. . .

Lag Screws Anchor A Concrete Tank

To prevent uplift flotation of a large concrete tank, a simple lag screw anchoring device, fastened to the foundation piles, was used in the construction of the Hackensack, N. J., sewage disposal plant. As shown in the accompanying sketch, a 4-in. square iron washer was welded to the head of a $\frac{7}{8}$-in.-diameter lag screw; the latter is $14\frac{1}{2}$ in. in length. The anchor was screwed into a $\frac{3}{4}$-in. hole drilled in the center of the wood pile. The top of the washer was kept at the proper elevation to act as a support for steel reinforcing used in the bottom concrete slab of the tank. Some 800 piles in the foundation were equipped with these anchors, at a cost of about $1 each including labor and materials in placing.



Lag screw anchorage keeps a concrete tank from floating.

In a laboratory test program this screw anchor withstood a pull of 10,200 lb. before it moved and it could not be withdrawn until a pull of 16,400 lb. was exerted. The device was developed by Lee Campbell, director of public works and designer of the Hackensack plant.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Data on Air Conditioning

HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1939—1,160 pp. Published by the American Society of Heating and Ventilating Engineers, New York. Price, $5; thumb indexed edition, $5.50.

THE REFRIGERATING DATA BOOK—Fourth Edition—Vol. 1—527 pp. Published by The American Society of Refrigerating Engineers, New York, N. Y. Price $4 in U. S.; $4.50 elsewhere.

AIR CONDITIONING PRINCIPLES AND PRACTICE—By B. H. Jennings and S. R. Lewis. 467 pp. Published by International Textbook Co., Scranton, Pa. $4.

WINTER AIR CONDITIONING—532 pp. Published by National Warm Air Heating & Air Conditioning Association, Columbus, Ohio. Price $3.

DESIGN OF INDUSTRIAL EXHAUST SYSTEMS—By John L. Alden, 220 pp. Published by The Industrial Press, New York; Machinery Publishing Co., London. Price $3.

The increasing number of books on air conditioning and related subjects stands as clear evidence of the broadening interest in that field. "Heating, Ventilating, Air Conditioning Guide—1939" is an annual published by the American Society of Heating and Ventilating Engineers. In addition to a large amount of technical data it includes a catalog section and a list of members of the organization. "Refrigerating Data Book" is a somewhat similar publication by the American Society of Refrigerating Engineers, a book that has been published biennially since 1932. The preface states that work has begun on an entirely new book to be published in 1941. It will appear in two volumes, "Refrigerating Principles and Machinery" and "Applications of Refrigeration."

In "Air Conditioning Principles and Practice" a college professor and a consulting engineer specializing in heating and ventilating work have cooperated to produce a book that will be useful both to the student and to the practitioner in the air conditioning field. The book is prepared on the basis that the reader has knowledge of elementary thermodynamics and of the principles of engineering. Examples of complete solutions of air conditioning problems are freely used to demonstrate the method and principles outlined in the book.

"Winter Air Conditioning" is based on the results of research into warm-air heating conducted at the Engineering Experiment Station of the University of Illinois and published in Bulletin No. 266 of the Station. The present work supplements that study and adds new information developed since 1932.

"Design of Industrial Exhaust Systems," as the title indicates, treats of a subject closely related to air conditioning. It has been written, according to the author, to meet the present deficiency in fundamental data on the design of exhaust ducts and piping, also to express in straightforward engineering terms much information that has been disguised heretofore as trade secrets.

Municipal Public Works

PUBLIC WORKS ENGINEERS' YEARBOOK 1939—457 pp. Published by the American Public Works Association, Chicago. Price $3.50.

The Yearbook of the American Public Works Association is designed to furnish an authoritative review of events and developments in public works as well as to provide a medium for the publication of papers which are presented at the annual convention of the association. The 1939 edition of some 450 pages is divided into three parts; the first deals with an appraisal of developments in various fields, the second section consists of detailed discussion of selected problems of current interest, and part three is an account of the business proceedings of the association, including an alphabetical roster of members.

Both the administrative phases and engineering practices of public works activity are considered. Of particular interest in view of the trend toward scientific management of public service enterprises are those articles on planning and programing, personnel administration, and organization. And not to be overlooked is Mayor LaGuardia's pungent comment on the administration of public works in New York City. The 22 articles on engineering practice contain a wealth of information for the municipal administrator as well as the technician.

Subsidies to Highways

HIGHWAY COSTS—By C. B. Breed, Clifford Older and W. S. Downs. 150 pp. Published by the Association of American Railroads, Washington, D. C.

This pamphlet makes the startling finding that in the period 1921–1932 the motor vehicles using our highways were subsidized to the extent of almost ten billion dollars, or one quarter of the national debt! It finds further that since 1932 there has been little diminution in the subsidy, that in the five-year period 1933–37, three billion more was added.

The methods used in arriving at these figures are recognized accounting practices that are employed frequently in determining the rate base of public utilities, but the application of them to a determination of the extent to which this country really is subsidizing motor transportation is open to criticism as being highly impracticable even though theoretically correct. The authors set up the whole highway construction and maintenance undertaking as if it were a public utility which must borrow money, pay interest during construction, make annual amortization payments, pay interest on the unamortized balance, pay taxes and pay maintenance costs. Thus for the year 1937, when the direct expenditures on state highways, local roads and streets amounted to $1,047,000,000 for construction and $882,000,000 for maintenance and operation, or a total of $1,929,000,000, the total annual cost as computed by the methods used in this book becomes $2,332,000,000, of which $1,855,000,000 is considered to be directly chargeable to motor vehicles as against $1,162,000,000 paid in motor vehicle taxes.

Addition of nearly two billion dollars for "equivalent property taxes" in the periods under study in an attempt to put the highway users on a par with the railroad, seems to weaken rather than strengthen the case for the railroads because it is so obviously artificial. A simple statement of what we spend annually on highways, what it costs to service and

amortize outstanding bonds and what we pay for upkeep and policing set off against income from license fees and gas taxes would have been more understandable and convincing to many readers.

Despite its unrealistic approach to the question of the extent of the motor vehicle subsidy, this study is a welcome compilation of highway cost data in a more complete form than heretofore assembled. It does show that on the basis of direct annual income and outgo our motor vehicle taxes do not meet both construction and operating costs. Also, through a careful study of the proper method of allocating costs to various types of vehicles, the large trucks are shown to fall far short of bearing their proper share of construction and maintenance.

Labor Problems

THE WORKER, THE FOREMAN AND THE WAGNER ACT—By Russell L. Greenman. 137 pp. Published by Harper & Brothers, New York. Price $1.50.

"You can't fire me" is the attitude assumed by many workmen in all industries coming under the Wagner Act. They are right in some respects; wrong in others. A worker is protected by the act from discharge because of union activities, but no labor law yet written protects him from dismissal because of insubordination, incompetency or lack of work. Greenman points out in his interesting and highly readable discussion of management's problems under the Wagner Act that the foreman is the key man in labor relations. This is true whether the industry be textiles, shipbuilding or construction. The foreman is the direct representative of the employer in contacts with labor, and most all of the Labor Board's decisions have been based on the attitude and actions of the foreman in each case considered.

This useful book cites many of the board's decisions, and points out what the foreman can and cannot do under the act.

It is full of warnings and advice valuable to all employers. Contractors, handicapped by inability to supervise closely the acts of their foremen on widespread construction projects, will find here the basis of permitted practices in dealing with labor that they can pass on to the men in the field.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

TOLL ROADS AND FREE ROADS is the title of a pamphlet published by the Superintendent of Documents, Washington, D. C. (price, 75 cents) which contains a report of the Bureau of Public Roads on the feasibility of constructing a national network of express toll roads. The report was abstracted in our issue of May 11, p. 655.

THE INSTITUTE OF TRAFFIC ENGINEERS has put on a special sale of its annual Proceedings for the years 1934–37, inclusive. Information as to the price of the Proceedings can be obtained from the headquarters at 60 John St., New York City.

A STUDY of the safe performance possibilities of road vehicles prepared under the direction of H. M. Jacklin, associate professor of automotive engineering, Purdue University, has been published in multigraphed form by the Four Wheel Drive Auto Co., Clintonville, Wis.

TENNIS COURTS, playgrounds and recreation areas of asphalt are described in detail in a pamphlet published by the Kentucky Rock Asphalt Institute, Louisville, Ky. Included is information on drainage and base courses, also the dimensions for the principal types of courts.

THE SUPPLY of pamphlets outlining methods used by the Bureau of Engineering, Department of Public Works, of Chicago, for testing gas masks for operators handling chlorine in water purification plants, *is exhausted*, according to Loran D. Gayton, city engineer. Please do not apply for copies.

REPORTS ON BUILDING MATERIALS are being issued by the U. S. Department of Commerce under the title of "Building Materials and Structures." Among the available reports are the following:

BMS1, Research on building materials and structures for use in low-cost housing; BMS2, Methods of determining the structural properties of low-cost house construction; BMS3, Suitability of fiber insulating lath as a plaster base; BMS4, Accelerated aging of fiber building boards; BMS7, Water permeability of masonry walls; BMS8, Method of investigation of surface treatment for corrosion protection of steel; BMS9, Structural properties of "Frameless-Steel" constructions for low-cost houses. The pamphlets sell for ten cents apiece and may be obtained from the Superintendent of Documents, Washington, D. C. Other pamphlets are to follow.

NEW ENGINEERING BOOKS

ENGINEERING OPPORTUNITIES — Edited by R. W. Clyne. Published by D. Appleton-Century Co., New York. Price $3.

BUILDING CODE FOR CALIFORNIA—1939—Published by the California State Chamber of Commerce, 350 Bush St., San Francisco. Price $5.

SECOND CONGRESS, INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL ENGINEERING (English Edition)—Published by Wilhelm Ernst & Sohn, Berlin. 964 pp. Price 18 RM.

RELATORIO 1936 (Estudos, Projectos e Construcao)—Prepared by Ministeriro das Obras Publicas e Comunicacoes; Junta Autonoma Das Obras de Kidraulica Agricola. Volumes I and II.

THEORIE DU TASSEMENT DES COUCHES ARGILEUSES — By K. V. Terzaghi and O. K. Frohlich. Published by Dunod, 92, Rue Bonaparte (VI), Paris. 266 pp. Bound 115 francs; Paper 95 francs.

RAHMENFORMELN—By A. Kleinlogel. Published by Wilhelm Ernst & Sohn, Berlin. 460 pp. Price 17.25 RM.

THE NILE BASIN—By H. E. Hurst and P. Phillips. Obtained from Publications Office, Government Press, Bulaq, Cairo. 249 pp. Price P. T. 50 (10 shillings).

REPORTS AND PAMPHLETS

PAPERS PRESENTED AT SCHOOL FOR STREET SUPERINTENDENTS AND ASSISTANTS—Bulletin No. 17, Engineering Experiment Station, State College Station, Raleigh, N. C.

PROBEBELASTUNGEN UND PROBEBOHRUNGEN. Published by Leemann & Co., Zurich, Switzerland.

DAMS CONSTRUCTED BY CORPS OF ENGINEERS U. S. ARMY—Office, Chief of Engineers, Washington, D. C.

STANDARDS ON THE CLASSIFICATION AND COMPENSATION OF THE PROFESSIONAL ENGINEERING POSITIONS—Published by the American Association of Engineers, 8 South Michigan Ave., Chicago, Ill.

(Continued on p. 82)

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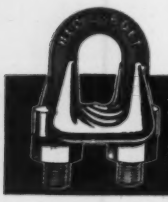

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REPORTS AND PAMPHLETS

(*Continued from page* 80)

STANDARD SPECIFICATIONS FOR GYPSUM PLASTERING — Obtainable from the American Standards Association, 29 West 39th St., N. Y. Price 25c.

SIMPLE BLUEPRINT READING with Particular Reference to Welding and Welding Symbols of the American Welding Society. Published by The Lincoln Electric Co., Cleveland, O. Price 50c. postage prepaid in U. S. and 75c. postage prepaid elsewhere.

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ORIGINAL COST FOR UTILITY ACCOUNTING—By Samuel Cahan. Obtainable from the Public Service Commission, 80 Centre St., New York, N. Y. Price 25c.

CAMINOS ESTABILIZADOS—By Juan Ignacio Planas. Published by La Sociedad Cubana de Ingenieros, Havana, Cuba.

2° CICLO DE CONFERENCIAS sobre temas Argentinos 1938—F. U., Centro Estudiantes de Ingenieria, La Plata, Argentina.

THE METHOD FOR THE MECHANICAL TESTING OF CEMENTS ADOPTED BY THE NEW BRAZILIAN SPECIFICATIONS—Published by the Institute for Technological Research of Sao Paulo.

UNIVERSITY OF COLORADO—Papers Presented at the Highway Conference Held at the University of Colorado on January 19, 1939.

THE PLACE OF THE ENGINEER IN CIVILIZATION—By D. B. Steinman. A series of addresses delivered before the Institute of Engineers, School of Engineering, University of North Carolina, State College Station, Raleigh, N. C.

TWO DECADES OF HYDRAULICS AT THE UNIVERSITY OF IOWA—Bulletin No. 19. Published by the University, Iowa City, Iowa.

HOW TO CHOOSE A PROFITABLE OCCUPATION—By Sumner Harwood and Associates. Published by Cambridge Analytical Services, 1430 Massachusetts Ave., Cambridge, Mass. Price $1.

LECONS SUR LES ESSAIS DE MATERIAUX—Part I, La Structure et le Déformation des Solides; Part II, Essais des Métaux. May be obtained from Hermann & Co., Editeurs, 6, Rue de la Sorbonne 6, Paris, France.

DISCUSSION OF INDUSTRIAL ACCIDENTS AND DISEASES—Bulletin No. 24. May be obtained from The Superintendent of Documents, Washington, D. C. Price 30c.

THE MECHANICAL TESTING OF BITUMINOUS ROAD MATERIALS—May be obtained from the British Library of Information, 50 Rockefeller Plaza, New York. Price 30c.

STRENGTH OF RIVETED STEEL RIGID FRAME HAVING STRAIGHT FLANGES—Research Paper RP1130, U. S. Dept. of Commerce, National Bureau of Standards, Washington, D. C.

ECONOMIC STUDIES OF MARYLAND, Parts I and II—May be obtained from the Maryland State Planning Commission, Latrobe Hall, The Johns Hopkins University, Baltimore, Maryland. Price 25c.

NATIONAL PAVING BRICK ASSOCIATION—1938 Proceedings of 32nd Annual Meeting.

THE UNITED STATES LAKE SURVEY—Published by The U. S. Lakes Survey, Detroit.

LITTLE ROCK, ARKANSAS: Second and Third Annual Report—1937-38, Municipal Water Works.

COLORADO: Department of Water Resources, 28th Biennial Report of the State Engineer to the Governor.

SPRINGFIELD, Mass.: 65th Annual Report of the Water Commissioners, 1938.

CITY OF SAN JOSE, California: Municipal Report for 1938.

NEW YORK: Annual Report of the State Planning Council for the Division of State Planning—1938.

NEW YORK CITY: Annual Report of the City Planning Commission and the Department of City Planning. Obtainable from the Municipal Building, New York City, 50c.

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CONCORD, N. H.: 67th Annual Report of the Board of Water Commissioners, 1938.

READING, Mass.: Annual Report, 1938, Board of Public Works.

KANSAS, Topeka: Seventh Annual Report and Roster of Professional Engineers—1938.

KING COUNTY, Wash.: Fourth Annual Report of the County Road Engineer—1938.

PORTLAND, Ore.: 28th Annual Report of the Commission of Public Docks—1938.

PROCEEDINGS of the 25th Annual Highway Conference. Published by the University of Michigan, Ann Arbor, Mich.

LARCHMONT, New York. Annual report for the year 1938.

SUFFOLK COUNTY—Report of the Mosquito Extermination Commission.

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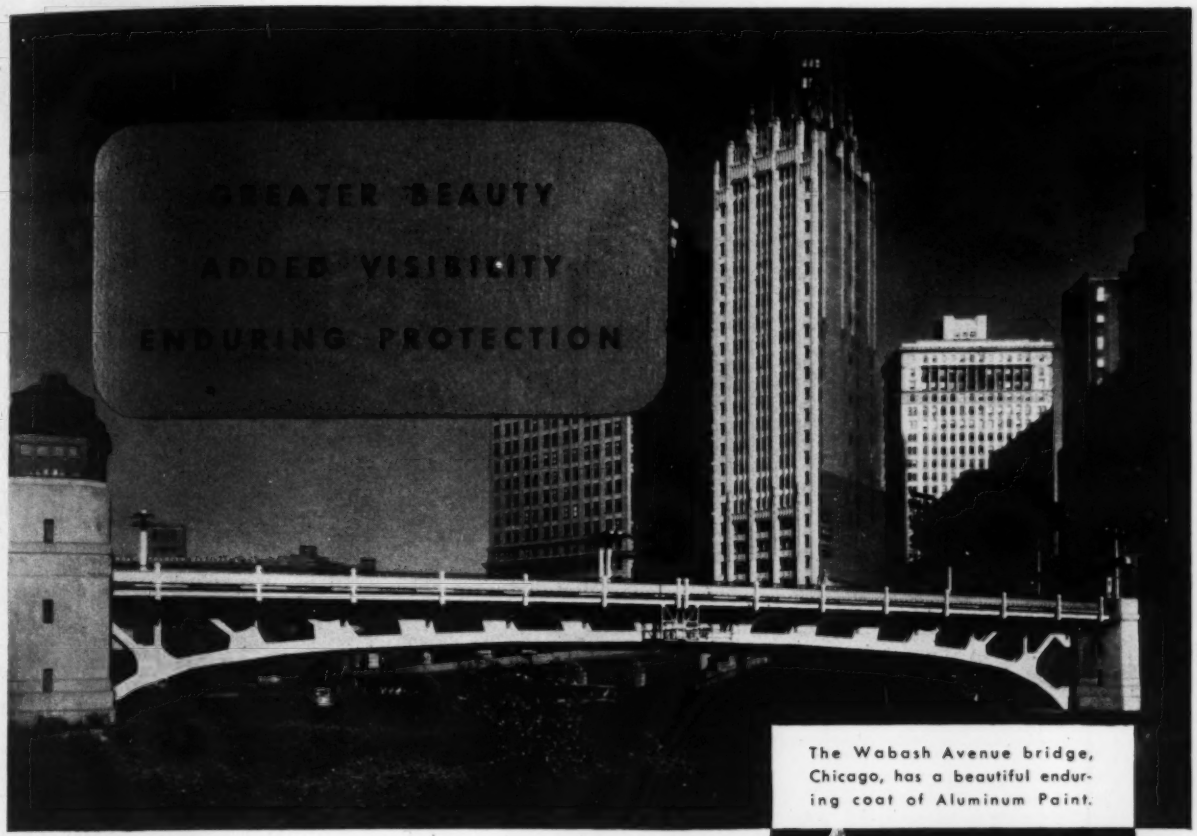

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WATERWORKS IMPROVEMENTS MISSISSIPPI

OWNER: City of Pascagoula, Mississippi. L. C. Winterton, Pascagoula, engineer.

PROJECT: Improvement of waterworks, consisting of laying approximately 50,000 ft. of new water mains, and removing and relaying about 6,000 ft. of 4 and 6-in. mains, together with necessary connections and fittings.

CONDITIONS: All materials to be furnished by contractor. Rail, road and water transportation available. Wage rates are: skilled, 75c. per hr.; semi-skilled, 45c.; and common labor, 25c. per hr.

BIDS: Thirteen bids were received on March 18, 1939, ranging from the contract low of $54,966 to $71,139.

LOW BIDDERS:

1. J. B. McCrary Co., Atlanta, Ga. (contract).... $54,966
2. C. H. Cash, Inc., Buena Vista, Ga..... 55,191
3. Boyce & Co., Clearwater, Fla..... 55,960

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 10-in. C. I. pipe	2,977 l. f.	$1.77	$1.85	$1.77
2. 8-in. C. I. pipe	6,527 l. f.	1.36	1.40	1.35
3. 6-in. C. I. pipe	10,363 l. f.	1.03	1.04	1.00
4. 4-in. C. I. pipe	22,085 l. f.	.77	.75	.74
5. 10-in. gate valves	8 ea.	59.30	65.00	71.00
6. 8-in. gate valves	14 ea.	36.60	40.00	38.00
7. 6-in. gate valves	19 ea.	24.50	27.00	25.00
8. 4-in. gate valves	52 ea.	15.50	17.00	19.00
9. 4-in. fire hydrants	31 ea.	45.75	52.00	47.00
10. 5-in. fire hydrants	39 ea.	56.75	65.00	57.50
11. Service line conn	425 ea.	3.00	4.00	4.20
12. Copper pipe, type K	8,510 l. f.	.27	.24	.25
13. Lumber, No. 2, com	1 M bm.	30.00	40.00	70.00
14. Excav	100 c. y.	.70	.50	1.00
15. Remove 6-in. C. I. pipe	2,156 l. f.	.25	.17	.45
16. Remove 4-in. C. I. pipe	3,946 l. f.	.25	.17	.40
17. Remove 6-in. gate valves	2 ea.	1.50	2.00	5.00
18. Remove 4-in. gate valves	5 ea.	1.50	2.00	3.00
19. Remove 5-in. fire hydrants	3 ea.	5.00	2.00	6.00
20. Remove 4-in. fire hydrants	8 ea.	4.00	2.00	6.00
21. Relay 6-in. C. I. pipe	2,456 l. f.	.29	.26	.35
22. Relay 4-in. C. I. pipe	4,696 l. f.	.28	.21	.29
23. Relay 6-in. gate valves	2 ea.	1.50	3.00	3.00
24. Relay 4-in. gate valves	5 ea.	1.50	3.00	2.50
25. Relay 5-in. hydrants	3 ea.	5.00	10.00	5.00
26. Relay 4-in. hydrants	8 ea.	4.00	10.00	5.00

WATERWORKS, KANSAS

OWNER: City of Grinnell, Kansas. Paulette & Wilson, Salina and Topeka, Kans., engineers.

PROJECT: Construction of waterworks system, except pump, at Grinnell. Bids were taken on lump sum basis, and the unit prices tabulated below are to apply in the event of under-runs from the contract.

BIDS: Nine bids were received March 17, 1939, ranging from the contract low of $23,970 to $28,168. Contract awarded April 28. Engineer's estimate, $26,918.

LOW BIDDERS:

1. C. L. Burt, Hutchinson, Kans. (contract)..... $23,970
2. W. B. Carter, Wichita, Kans..... 24,675
3. P. P. Young, St. Joseph, Mo..... 24,995

Item	Unit	Unit Prices (1)	(2)	(3)
1. Excav	c. y.	$0.55	$0.90	$0.60
2. Trench, 4 to 6 ft. deep	l. f.	.10	.09	.08
3. 6-in. B&S C.I. pipe	l. f.	1.09	1.05	1.15
4. 4-in. B&S C.I. pipe	l. f.	.75	.75	.75
5. 2-in. B&S C.I. pipe	l. f.	.35	.40	.40
6. C. I. fittings, B&S	ton	154.00	150.00	160.00
7. 6-in. gate valves	ea.	26.00	25.00	26.00
8. 4-in. gate valves	ea.	16.60	15.00	17.00
9. 2-in. gate valves	ea.	10.25	10.00	10.00
10. 4-in. fire hydrants	ea.	55.00	58.00	55.00
11. C. I. valve boxes	ea.	5.50	4.00	5.00
12. ¾-in. copper pipe	l. f.	.33	.30	.30
13. 1-in. copper pipe	l. f.	.44	.40	.36
14. ⅝-in. water meter	ea.	9.35	7.50	8.00
15. 1-in. water meter	ea.	20.90	16.50	17.00
16. ⅝-in. meter jumper	ea.	2.00	1.00	1.50
17. V. C. meter boxes	ea.	6.60	6.00	8.00
18. ¾-in. corporation cocks	ea.	2.65	3.50	6.00
19. 1-in. corporation cocks	ea.	4.00	6.00	7.00
20. Cl. 2 conc	c. y.	15.40	15.00	18.00
21. Reinf	lb.	.06	.06	.05
22. Conc. sidewalk	s. f.	.30	.25	.50

GRADE SEPARATION NEW YORK

OWNER: Department of Parks, New York City, R. Moses, Commissioner; R. G. Hoff, engineer.

PROJECT: Grade separation at Rockaway Parkway and paving from Flatbush Ave., to Pennsylvania Ave., Brooklyn, N. Y. Contract MS 39-12.

CONDITIONS: Project must be completed by April 1, 1940. Contractor to furnish all materials. Rail, highway and water transportation facilities available.

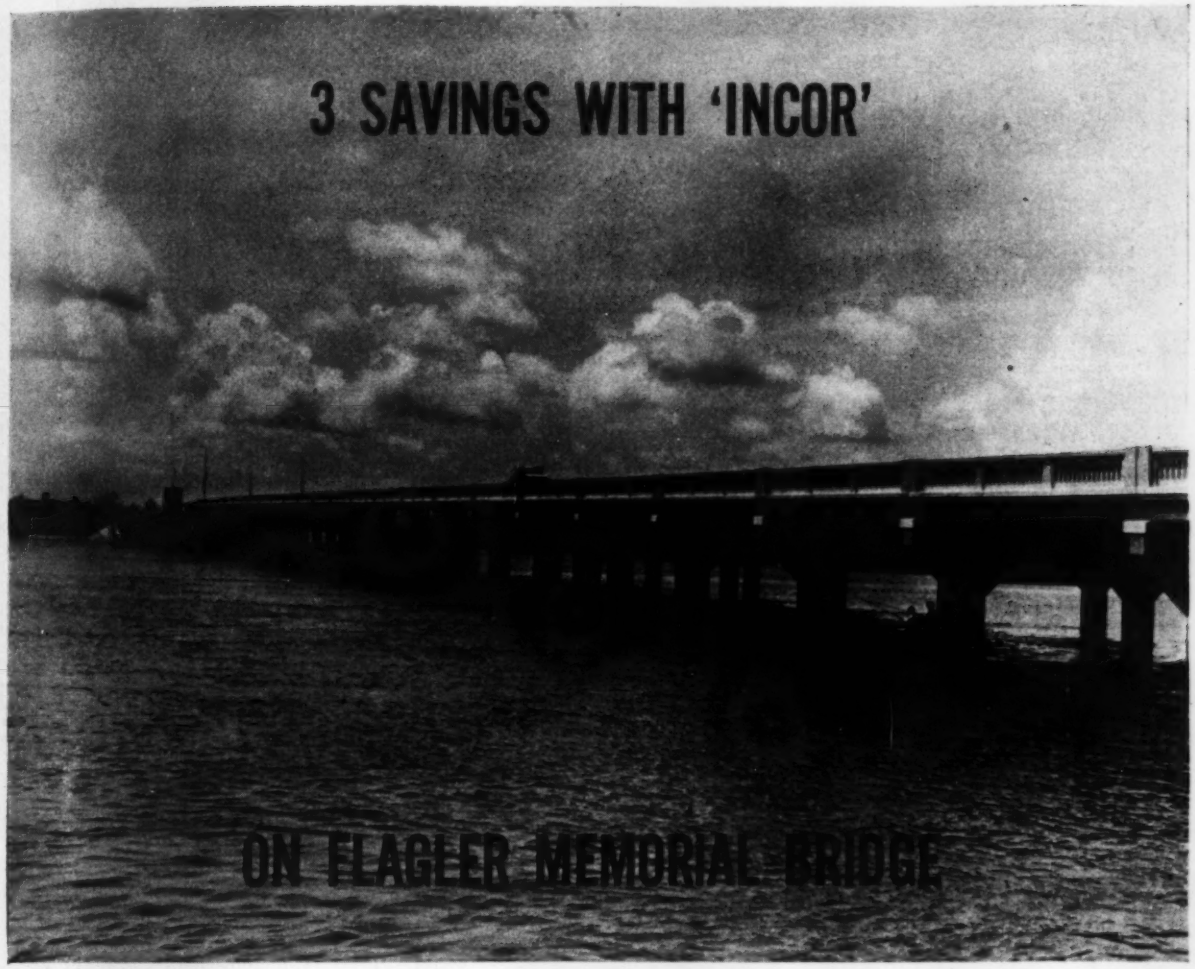
BIDS: Ten bids were received on May 12, 1939, ranging from the contract low of $658,717 to $999,523. Contract awarded to low bidder on June 2.

LOW BIDDERS:

1. Johnson, Drake & Piper, Freeport, N. Y. (contract) $658,717
2. Wm. F. McDonald Constr. Co., Flushing, N. Y. 662,786
3. A. W. Banks, Inc., Winfield, N. Y..... 683,054

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Unclass. excav	275,000 c. y.	$0.21	$0.30	$0.30
2. Trim shoulders	L. S.	2,000.00	4,000.00	3,000.00
3. Prep. fine grade	135,000 s. y.	.12	.10	.20
4. Pipe underdrain, 6-in	280 l. f.	.35	.25	.30
5. Reinf. conc. pipe, 15-in	18,200 l. f.	1.25	1.25	1.40
6. Reinf. conc. pipe, 18-in	3,000 l. f.	1.50	1.50	1.60
7. Reinf. conc. pipe, 24-in	3,000 l. f.	2.25	2.40	3.00
8. Reinf. conc. pipe, 30-in	500 l. f.	3.50	3.75	4.00
9. Reinf. conc. pipe, 36-in	100 l. f.	4.50	5.00	6.00
10. Reinf. conc. pipe, 42-in	100 l. f.	5.50	6.00	7.00
11. Portland cement	45,400 bbl.	2.10	2.20	2.25
12. Natural cement	6,800 bbl.	2.90	3.00	2.80
13. Spec. Portland cement	1,100 bbl.	3.00	3.00	3.00
14. White Port. cement	420 bbl.	6.25	7.00	6.00
15. Conc., structures (1:1½:3½)	320 c. y.	25.00	28.00	21.00
16. Cl. 1 conc. (1:2:4 mix)	510 c. y.	18.00	16.00	20.00
17. Dimension masonry	5 c. y.	180.00	200.00	160.00
18. Metal reinf., conc. pavmt.	120,000 s. y.	.27	.25	.27
19. Joint supports	12,000 l. f.	.50	.65	.55
20. Bar reinf., struct	293,000 lb.	.045	.05	.055
21. Struct. steel	425,000 lb.	.06	.045	.06
22. Misc. iron and steel	214,000 lb.	.06	.05	.07
23. Cement conc. pavmt	26,500 c. y.	7.90	7.50	7.20
24. Bitum. mat'l. waterpr'f'g.	65 gal.	.60	.40	1.00
25. Closed end steel pipe piles.	4,900 l. f.	3.50	4.00	2.50
26. Loading tests, piles	5 ea.	200.00	250.00	100.00
27. Broken stone, loose meas.	110 c. y.	4.00	5.00	4.50
28. Separate conc. curbing	3,400 l. f.	.55	.60	.50
29. Catch basin, type A, 3-7 ft. deep	140 ea.	90.00	70.00	65.00
30. Catch basin, type A, 7-9 ft. deep	80 ea.	123.00	90.00	65.00
31. Catch basin, type A, 9-11 ft. deep	10 ea.	150.00	100.00	100.00
32. Catch basin, type A, 11-13 ft. deep	2 ea.	170.00	120.00	125.00
33. Catch basin, type A, 13-15 ft. deep	1 ea.	190.00	140.00	160.00
34. Manholes, type A, 3-7 ft. deep	1 ea.	110.00	70.00	65.00

(Unit Prices continued on p. 86)



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(Continued from p. 84)

35. Manholes, type A, 7-9 ft. deep	1 ea.	140.00	90.00	65.00
36. Manholes, type A, 9-11 ft. deep	1 ea.	160.00	100.00	75.00
37. Manholes, type A, 11-13 ft. deep	1 ea.	170.00	120.00	125.00
38. Manholes, type A, 13-15 ft. deep	1 ea.	200.00	140.00	150.00
39. Manholes, type C	15 ea.	140.00	150.00	50.00
40. Manholes, type F-3	8 ea.	80.00	80.00	50.00
41. Change elev., manholes and c. basins	5 ea.	10.00	20.00	20.00
42. Conc. sidewalk	1,200 s. y.	1.75	2.00	1.50
43. Stone masonry	111 s. y.	20.00	20.00	25.00
44. Stone masonry, laid dry	520 s. y.	8.00	7.00	13.00
45. Conc. curbing, steel faced	4,100 l. f.	1.50	2.00	2.00
46. Maint. and protect traffic	L. S.	10,000.00	1,000.00	7,000.00
47. Timber guide rail, type A, low	7,200 l. f.	1.00	1.00	.85
48. Timber guide rail, type B, high	3,400 l. f.	1.50	1.25	1.60
49. Black steel pipe, 2-in	3,700 l. f.	.45	.50	.45
50. Black steel pipe, 4-in	500 l. f.	1.05	1.10	1.05
51. Cobble gutter	100 s. y.	4.00	4.00	2.50
52. Sheet asphalt pavmt	8,000 s. y.	1.75	2.25	2.20
53. Electr. equipment	L. S.	1,500.00	1,000.00	1,050.00
54. Copper bearing conduit	6,000 lb.	.20	.20	.18
55. Transite conduit, 4-in	800 l. f.	.70	.70	.80
56. Black steel conduit	7,000 lb.	.18	.20	.13
57. Hollow metal doors	L. S.	1,000.00	400.00	2,500.00

WATERWORKS IMPROVEMENTS GAINESVILLE, FLORIDA

OWNER: City of Gainesville, Fla. Robert & Co., Atlanta Ga., engineers.

PROJECT: Waterworks, improvements, including water mains, gate valves and boxes, and hydrants.

CONDITIONS: Contract awarded April 27, and must be completed in 105 calendar days. Contractors to furnish all materials. Wage rates on the job are: skilled, $1.00 per hr.; semi-skilled, 40 to 60 c. per hr.; and common labor, 30 c. per hr.

BIDS: Three bids were received on March 27, ranging from the contract low of $13,136 to the high of $13,314.

LOW BIDDERS:

1. J. L. Kelly, Miami, Fla. (contract) $13,136
2. M. R. Boyce Co., Clearwater, Fla. 13,305
3. Ivy H. Smith Co., Jacksonville, Fla. 13,314

		Unit Prices		
Item	Quan.	(1)	(2)	(3)
1. 6 in. water main	7,670 l. f.	$1.23	$1.20	$1.14
2. 6 in. gate valves and boxes	30 ea.	28.00	40.00	35.00
3. 4 in. water main	2,220 l. f.	.82	.80	1.00
4. 4 in. gate valve and box	1 ea.	22.00	20.00	25.00
5. Fire hydrants	17 ea.	60.00	65.00	75.00

CHANNEL WORK, PA.

OWNER: U. S. Engineers, Pittsburgh office.

PROJECT: Channel improvements, Conemaugh River, Johnstown, Pa.

BIDS: Five bids were received May 31, 1939, ranging from $976,081 to $1,216,709. Low bidders were: 1. Al Johnson Const. Co., Minneapolis; 2. Seeds & Durham, Philadelphia; 3. Minder Const. Corp., Chicago.

		Unit Prices		
Item	Quan.	(1)	(2)	(3)
1. Common excavation	520,000 c. y.	.63	.66	.84
2. Rock excavation	115,000 c. y.	.63	1.40	.84
3. Special excavation	11,000 c. y.	2.00	2.58	2.00
4. Special rock excavation	4,200 c. y.	5.00	8.90	7.50
5. Uncompacted fill	94,000 c. y.	.10	.07	.05
6. Compacted fill	65,000 c. y.	.25	.14	.25
7. Gravel backing	11,000 c. y.	2.60	2.50	3.00
8. Rock fill	1,400 c. y.	1.00	1.57	1.00
9. Concrete	26,500 c. y.	11.00	10.60	11.00
10. Furnishing and placing reinforcing steel	1,700,000 lb.	.04	.045	.042
11. Furnishing cement	34,000 bbl.	2.30	2.50	2.47
12. Alterations to pipe outlet	L.S.	6,000.00	1,420.24	4,000.00
13. Relocation of sewer siphon	L.S.	15,000.00	2,721.00	12,000.00
14. 39-inch concrete pipe	725 l. f.	15.00	8.00	7.00
15. 60-inch concrete pipe	50 l. f.	20.00	11.46	15.00
16. Furnishing and installing copper water stops	1,200 lb.	1.00	.37	1.25
17. Rock paving in gutters	670 s. y.	2.00	1.80	5.00
18. Furnishing and installing flap valves	L.S.	2,000.00	250.00	1,500.00
19. Furnishing and installing pipe railing	1,133 l. f.	2.00	2.72	3.00

TEST BORINGS, SEWER BRONX, NEW YORK

OWNER: Department of Public Works, Municipal Building, New York, N. Y., E. I. Judd, supervising engineer.

PROJECT: Contract 1, test borings for East Bronx Intercepting Sewer, Wards Island Sewage Treatment Works, on E. 133rd St. near St. Ann's Ave., east to Locust Ave., then north past 144th St.

CONDITIONS: Must be completed in 60 consecutive days. Rail, water, and highway transportation facilities available. Contractor furnishes all labor and materials.

BIDS: Two bids were received on May 29, $2,791 and $2,914.

LOW BIDDERS:

1. Sprague & Henwood, New York, N. Y. (contract) $2,791
2. Battle Bros. Drilling Co., Scranton, Pa. 2,914

		Unit Prices	
Item	Quan.	(1)	(2)
1. Sinking casings	560 l. f.	$2.90	$2.50
2. Dry samples	110 ea.	1.00	1.00
3. Diamond drill, for 1¼ in. rock cores	330 l. f.	2.90	3.95
4. Ground wat. determin. (strainer meth.)	100 l. f.	1.00	1.00

FLOOD WALL MASSACHUSETTS

OWNER: U. S. Engineers, Federal Building, Providence, R. I.

PROJECT: Constructing reinforced concrete flood wall, 2,480 ft. long, approximately 12 ft. high, along east bank of Connecticut River, in south portion of Chicopee, Mass. Steel sheet piling cut-off.

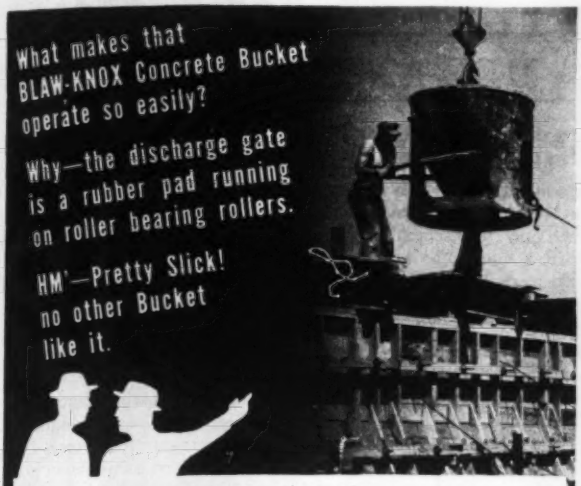
CONDITIONS: Cantilever wall construction requires excellent forms, and there is considerable form work for quantity of concrete involved. Existing sewers require careful work. Contractor to furnish all material. Rail and highway transportation facilities available. Wage rates: Skilled, $1.50; semi-skilled, 62 to 75 c. per hr.; and common labor, 56 c. per hr. Stipulated contract time, 120 calendar days.

BIDS: Four bids were received June 22, 1939, ranging from the contract low $117,241 to $146,037. Engineer's estimate, $154,958.

LOW BIDDERS:

1. Charles I. Hosmer, Inc., Greenfield, Mass. (contract) $117,241
2. Frank T. Westcott, North Attleboro, Mass. 124,717
3. Lane Constr. Corp., Meriden, Conn. 125,294

		Unit Prices		
Item	Quan.	(1)	(2)	(3)
1. Prepare site	3.9 acre	$300.00	$500.00	$350.00
2. Common excav	16,300 c. y.	.40	.40	.50
3. Remove existing wall	8 c. y.	5.00	12.00	10.00
4. Steel sheet piling	37,000 s. f.	.90	.90	.90
5. Gravel, pea stone, fltr. sand	2,700 c. y.	2.00	2.50	2.45
6. Compacted backfill	7,800 c. y.	.30	.25	.35
7. Rock fill	2,500 c. y.	2.50	2.00	3.25
8. Riprap, hand placed	3,800 c. y.	4.00	3.50	4.25
9. 8 in. V. C. pipe	750 l. f.	.50	.50	.50
10. 8 in. V. C. pipe, perf	380 l. f.	.80	.60	.60
11. 12. in. V. C. pipe	710 l. f.	.90	.80	.70
12. 12 in. V. C. pipe, perf	350 l. f.	1.25	1.00	1.00
13. 12 in. corr. met. pipe, incl. seep rings and flap valve	L. S.	150.00	150.00	250.00
14. Cement	3,800 bbl.	2.50	2.50	2.40
15. Concrete, cl. A	2,770 c. y.	9.35	12.00	9.50
16. Steel reinforc	217,850 lb.	.035	.04	.04
17. Misc. iron and steel	3,550 lb.	.12	.12	.15
18. Copper water stops	1,000 lb.	.45	.40	.50
19. Topsoil	850 c. y.	1.00	1.50	1.50
20. Sod and seed	1.05 acre	300.00	500.00	450.00
21. Close exist. manhole	L. S.	50.00	100.00	150.00


What makes that BLAW-KNOX Concrete Bucket operate so easily?
Why—the discharge gate is a rubber pad running on roller bearing rollers.
HM'—Pretty Slick! no other Bucket like it.

• Controllable discharge, Blaw-Knox CONCRETE BUCKETS are a popular concrete placing unit. Used by contractors everywhere.

Send for a copy of the catalog on Blaw-Knox Concrete Buckets, No. 1586.

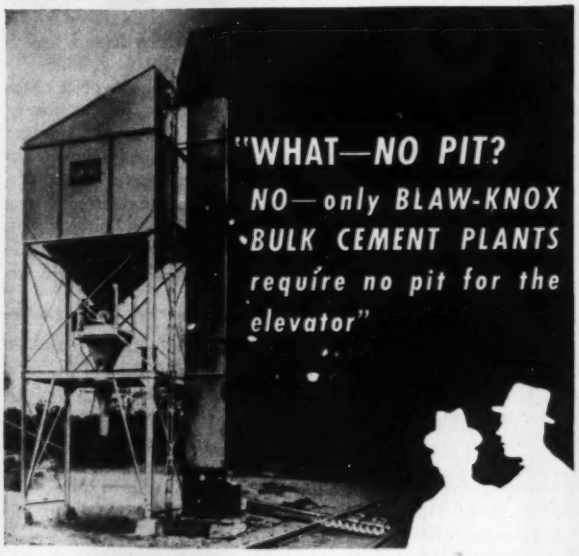
BLAW-KNOX DIVISION of Blaw-Knox Company
FARMERS BANK BUILDING · PITTSBURGH, PA.

BLAW-KNOX *Roller Gate* CONCRETE BUCKETS

Yes, sealed ball bearing sheaves keep lubrication in and dirt out, to prevent excessive wear and prolong the life of the bucket. In addition Blaw-Knox Buckets make generous use of tough alloy steels to avoid excessive dead weight and provide worthwhile savings in rehandling costs. Write Blaw-Knox today for Bulletin 1606.

16

BLAW-KNOX BLAW-KNOX DIVISION · OF BLAW-KNOX CO · Farmers Bank Bldg Pittsburgh, Pa
Digging and Rehandling **BUCKETS**



Blaw-Knox **BULK CEMENT PLANTS** are the ultimate in portability, speed, and convenience of use and operation. They are *complete units* for unloading, storage, batching and handling of bulk cement—dependable and accurate.

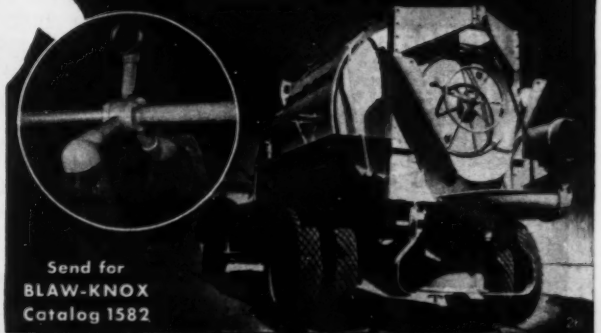
21 Completely described in Blaw-Knox Catalog No. 1566. Send for copy.

BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO Farmers Bank Bldg Pittsburgh, Pa
Bulk Cement Plants

FAST WATER!

"MAN... That new WATER IMPELLER in BLAW-KNOX TRUKMIXERS puts water into the batch in one-third the time formerly required."

The new, fast water impeller that won't clog; an accurate and dependable water measuring system; superb mixing action—and assurance of dependable continuous operation make Blaw-Knox Trukmixers the popular choice, and the practical buy for you. Study these features before you decide.



Send for BLAW-KNOX Catalog 1582

BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO Farmers Bank Bldg Pittsburgh, Pa
Agitators and **TRUKMIXERS**

You will revise upward your opinion of what constitutes efficient Locomotive Crane Service

When you check the performance of the

Sensational New

AMERICAN

40 and 50 ton

CRANES

—DIESEL AND GASOLINE—

Experienced plant executives are astounded at the Phenomenal Capacity, Speed and Ruggedness of these great cranes.

If you are using old style steam cranes you can buy New AMERICAN 40 and 50 Ton Locomotive Cranes out of SAVINGS.

If that sounds strong, say "Show me" and we will furnish facts and figures.

American Hoist and Derrick Co.

Saint Paul, Minn.

AMERICAN TERRY DERRICK COMPANY

South Kearny, N. J.

Branch Offices

NEW YORK & CHICAGO

The Genuine

CROSBY CLIP

(Continued from p. 41)

MEN AND JOBS

GEORGE PARKER, WPA official at Atlanta, Ga., July 1 will take over the duties in Washington of acting deputy administrator of the District of Columbia WPA. This will be the second transfer for Parker in a month, as he was shifted last week from Mississippi to Georgia.

HARLAN H. PARROWS, chairman of the geography department at the University of Chicago and member of the Water Resources Committee, has been engaged as consultant to direct development of 1,200,000 acres of farm land to be reclaimed by Grand Coulee Dam.

SAM H. BOTHWELL, city manager at Sweetwater for the last twelve years, will become city manager of Fort Worth, Texas Aug. 1. In the past he has been city manager of Longview, director of public works at Tyler, and city manager at Webster Groves, Mo.

CHARLES G. BROWN of Williamsport, formerly employed by the Sweets Steel Co., has been made safety engineer for the Pennsylvania department of highways. He is a graduate of Pennsylvania State College of Engineering.

ERNEST GOHIER, member of the engineering firm of LeBlanc & Gohier of Montreal and vice chairman of the Engineering Institute of Canada, has been appointed director-general of the Quebec Roads Department. He has acted as consulting engineer for the Montreal Metropolitan Commission, the Harbors of Quebec, Three Rivers and Chicoutimi, and various municipalities.

CLYDE L. SEAVEY, acting chairman of the Federal Power Commission since October 1937, was elected chairman July 8, and Claude L. Draper was named vice-chairman for the remainder of the year.

M. H. AVRAM, consulting engineer, who recently returned from Turkey upon completion of railway projects there, has been made director of the recently organized engineering department of Designs for Industry, Inc. He is a graduate of New York University and is author of the "Rayon Industry," "Patents and Inventions," and varied technical texts.

WILLIAM T. STUBBINS, formerly assistant engineer of construction for the Pennsylvania R.R. at Columbus, has been appointed engineer of District 23 of the National Youth Administration. He will be in charge of NYA construction projects and will act as consultant to county supervisors in planning projects.

M. C. SHIBLEY, former city engineer of Tulsa, will be placed in charge of the new Tulsa division of the Oklahoma State Highway Maintenance System on Aug. 1. Shibley's staff will include J. D. JENKINS, former maintenance engineer at Muskogee, as assistant engineer, and J. W. KLINGLESMITH, former division engineer at Perry, as assistant construction engineer.

PAUL CRANE will be in charge of the new division at Duncan of the Oklahoma highway department. His assistants will be A. H. Osborn, assistant maintenance engineer, and Joe Terry, assistant construction engineer. Other new division engineers are: L. S. DILLINGHAM, previously maintenance engineer at Antlers, at Muskogee, and C. O. BREWSTER, who has been advanced from assistant to division engineer at Perry.

COL. E. E. GESLER has been relieved of his duties as district engineer for the U. S. Engineers at Rock Island, a position he has held since Aug. 1936. He will begin new duties in the office of the Chief of Engineers in Washington on Sept. 1. While he was at Rock Island eleven dams were placed in operation on the Mississippi River as part of the 9-ft. canalization of that stream from St. Louis to the twin cities. COL. CHARLES F. GROSS, who is on a tour in Nicaragua at the present time, will succeed Col. Gesler.

CHARLES H. YOUNG, long consultant on drainage and flood control problems in the Upper Mississippi Valley, is retiring from active practice. A firm to be known as the Stanley Engineering Co. will take over the practice of Young & Stanley, Inc., of Muscatine, Ia. C. M. Stanley of the dissolving firm and A. E. Stanley, a brother, will be in charge.

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W. CLAUD SALE, construction engineer of the Oklahoma highway department, has resigned to take an appointment with the U. S. Engineers at Pittsburgh.

W. FRANK THOMAS, Westminster, Md., who was engaged in road construction work in Maryland for about

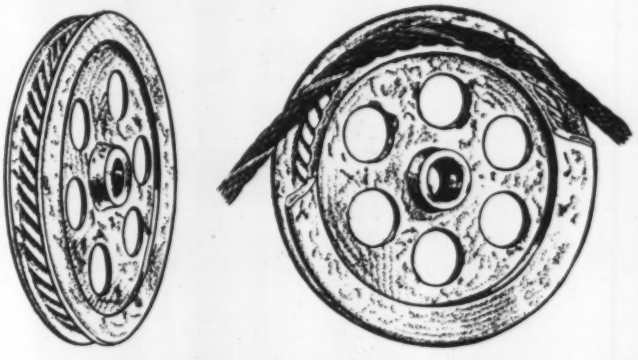
HOW SHEAVE MATERIALS AFFECT WIRE ROPE SERVICE

No. 2 in a series of informative articles for wire rope users, prepared by the MACWHYTE *wire rope company*

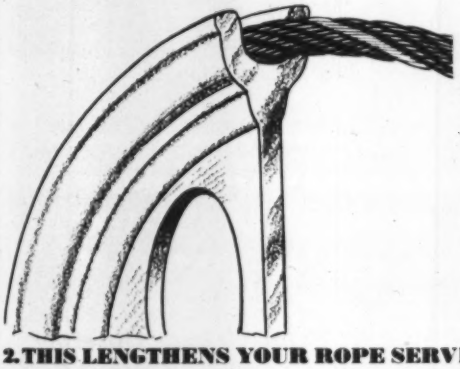
WATCH YOUR SHEAVES! *And Get Longer Wire Rope Service*

1. THIS DAMAGES YOUR ROPE

(a) Deep scoring of soft sheaves, pinch the rope and cause it to scrub on sheave flange.

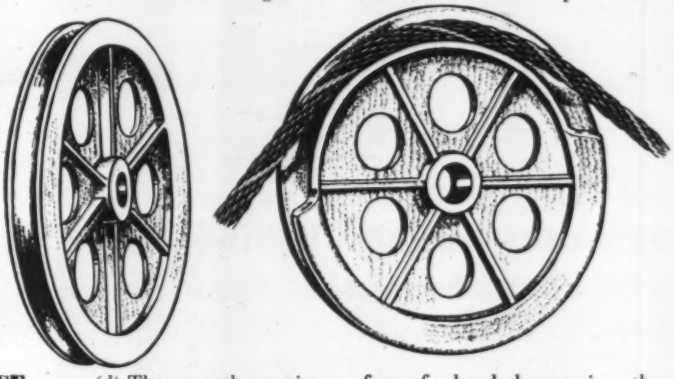


(b) SOFT SHEAVE often corrugates. A new rope does not "track" in the corrugations — Result — less wire rope service.



2. THIS LENGTHENS YOUR ROPE SERVICE

(c) A hard sheave does not easily score deeply and damage the rope.



(d) The smooth wearing surface of a hard sheave gives the rope a smooth bearing surface that lengthens the life of both sheave and wire rope.

NOTE: *Valuable for future reference*

3. IT IS FALSE ECONOMY to Operate Wire Rope Over Badly Scored and Corrugated Sheaves. WATCH YOUR SHEAVES ... Keep Them Smooth ... And Get Longer Wire Rope Service! The benefit of our experience on any problem pertaining to wire rope and its use is yours for the asking. It is part of our friendly service.

Contradictory as it may seem, a *soft* iron sheave that wears rapidly will cause more wear on a wire rope than sheaves made with *harder* materials.

Why Soft Sheaves Cause More Wear on Wire Rope.

A sheave of softer material than the wire rope is likely to take an impression of the wire rope and become deeply scored and corrugated, presenting a ragged surface which damages the rope and causes excessive wear.

A NEW WIRE ROPE USED ON A CORRUGATED SHEAVE WILL NOT "TRACK" IN THE CORRUGATIONS MADE BY THE PREVIOUS ROPE. IT WILL WEAR RAPIDLY AND NOT GIVE MAXIMUM SERVICE. THE GROOVE WILL ALSO WEAR DEEP AND THE FLANGE OF THE SHEAVE WILL CAUSE EXCESSIVE WEAR.

Why Hard Sheaves Increase Wire Rope Service.

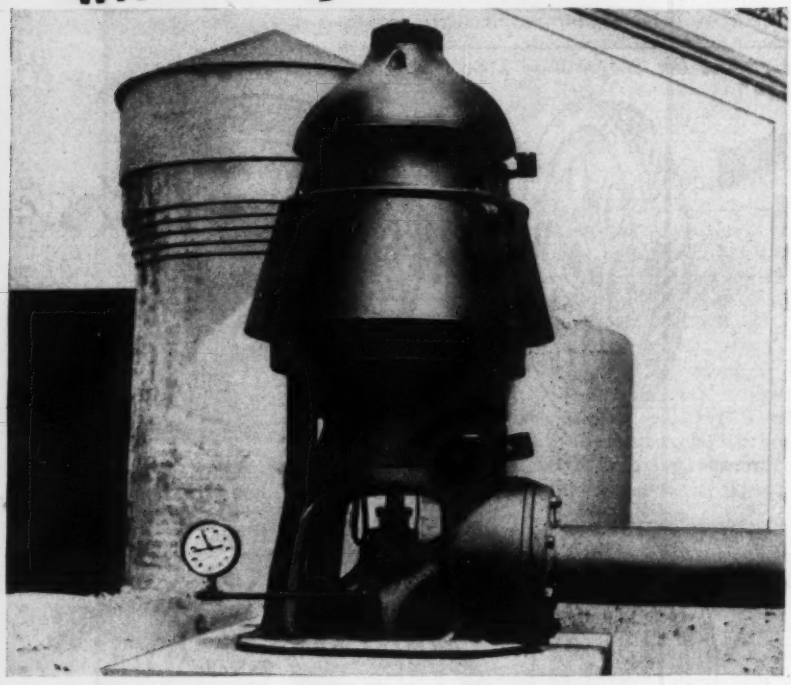
Sheaves made of harder materials ... such as carbon steel, manganese, other alloys, or "work-hardening" steels ... wear smooth, last longer and allow the rope to give the best service.

MACWHYTE COMPANY
KENOSHA, WISCONSIN

Manufacturers of PREformed, Internally Lubricated, Laboratory Tested, and Field Proved Wire Ropes, and Braided Wire Rope Slings for every use.
New York ... Pittsburgh ... Chicago ... Ft. Worth ... Portland ... Seattle ... San Francisco.
(Distributors throughout the U. S. A.)

REPRINTS AVAILABLE *of this and other informative articles on wire rope. Simply address: Macwhyte Co., Dept. 422, Kenosha, Wis.*

Twice THE WATER WITH One Third THE POWER!



Fairbanks-Morse Turbine Pump Cuts Costs for Lake Providence

For almost a quarter of a century Lake Providence, La. has been faithfully served by Fairbanks-Morse equipment in its municipally owned power, water, and sewage disposal plants. Small wonder, then, that the town has replaced its outmoded air-lift pumping system with a Fairbanks-Morse Fig. 6920 12-in. 3-stage turbine pump.

When the F-M Turbine pump—driven by a 40-hp. F-M ball-bearing, weatherproof motor—was first tested, it delivered more than 900 g.p.m. This is over *two-and-one-half times* the aggregate capacity of the air compressors it replaced. The pump's rated capacity is 800 g.p.m. against a total head of 120 feet at 1750 r.p.m.—and it uses only *two thirds of the power* consumed by the 60-hp. motors that operated the old air-lift system!

In thousands of installations requiring outstanding efficiency at low operating cost, Fairbanks-Morse pumps are first choice. A wide range of types and sizes makes it possible for you to select an F-M pump ideally fitted for practically any job. Fairbanks-Morse engineers will be glad to co-operate with you. Write Fairbanks, Morse & Co., Dept. 28, 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the United States and Canada.

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DIESEL ENGINES · PUMPS · ELECTRICAL MACHINERY · FAIRBANKS SCALES · RAILROAD EQUIPMENT · WATER SYSTEMS · WASHERS-IRONERS · FARM EQUIPMENT · STOKERS · AIR CONDITIONERS

Pumps

25 years before his retirement five years ago, has been appointed a member of the Maryland State Roads Commission. He succeeds J. Glenn Beall.

WILLIAM G. CRAWFORD is a building inspector on Louisville's east and west end slum clearance housing project.

RUT L. OSBORNE, Orangeburg, S. C. business man and a former comptroller general of the state, has been elected to the state highway commission to fill the unexpired term of the late Edgar L. Culler of Orangeburg.

L. D. BACON, former area engineer for WPA at Albany, Ga., succeeds M. C. Harrington in this position at Augusta.

L. T. MCKEE of Lyons, Kansas, has been named city engineer for Enid, Okla., succeeding Richard Hopper.

THOMAS A. BEDFORD has retired from the California state division of highways after 27 years of service.

LUCIAN BROUSSEAU has been appointed engineer of maintenance of way for the central region of the Canadian National Railroad.

FRED BRANDIS, city engineer for Chinook, Montana, has been awarded a plaque by the American Water Works Association in recognition of his 25 years of faithful service with the Chinook water plant.

• • •

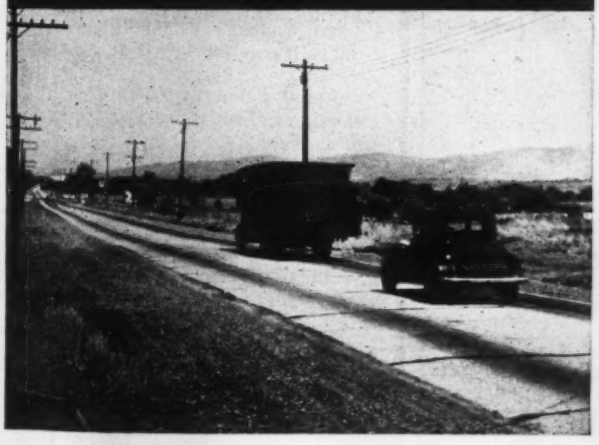
Pennsylvania Governor Vetoes Flood Control Curb

Legislation passed by the Pennsylvania General Assembly which would have suspended federal flood control work in the state was vetoed by Gov. Arthur H. James, June 26th.

The bill was designed to prevent the establishment of a "little TVA" in Pennsylvania by developing hydroelectric power through the use of flood control reservoirs.

In vetoing the bill, Gov. James said: "The bill presents a broad problem of the comparative rights of the federal government and the state government in the acquisition and use of lands and waters within the Commonwealth of Pennsylvania. Although we are of the opinion that this bill would not conflict with any specific federal statutes dealing with flood control, it would contravene broad constitutional problems regarding the supremacy of the federal government in the performance of public works, which would undoubtedly rebound to the detriment of the

FOR, THE ELEPHANT ATE ALL NIGHT
AND THE ELEPHANT ATE ALL DAY.
DO WHAT WE COULD TO FURNISH HIM FOOD
THE CRY WAS STILL "MORE HAY!"



MAINTENANCE COSTS ARE LOW IN NEW JERSEY. Built in 1913, New Jersey's first mile of concrete continues to "take it." In spite of very heavy average traffic, New Jersey's network of concrete roads of varying ages averaged only $169.41 per mile per year for surface maintenance over a recent 7-year period—only 1/3 to 1/6 as much as the next two most economical types.

"WHITE ELEPHANT" ROADS?

Not where CONCRETE *is the standard!*

Roads needing constant maintenance and repairs are aptly called "white elephants."

Because of high maintenance charges for such roads built in the past, some states and counties are finding they have inadequate funds for new construction. Work on needed new roads, bridges, grade separations and other vital improvements is nearly at a standstill. What was once thought to be "low-cost construction" is turning out to be very high-cost construction.

This important statement of principle is now widely recognized:

The ultimate or "annual transportation" cost of a highway is the critical cost. Surface maintenance is so important a cost factor that it may often be a *DECIDING* factor in the selection of design types, in the interest of economy alone.

Concrete Saves Millions in Maintenance

How does concrete stand when subjected to this test? A summary of costs in all states having comparable records available—covering 135,000 miles of state highways—shows that surface maintenance for concrete averages about $103 per mile per year —$88 to $465 *less* than for other surfaces. In general the concrete roads carried the heaviest traffic.

Measured by first cost, length of life, maintenance cost and cost of vehicle operation, concrete is the LOW cost road.

PORTLAND CEMENT ASSOCIATION
Dept. A7c-17, 33 West Grand Avenue, Chicago, Ill.
A National Organization to Improve and Extend the Uses of Concrete

CONCRETE IS THE REAL LOW COST ROAD

P&H BACK FILLERS

Speed Up Completion of Pipe Laying Jobs!

This P&H Back Filler will really save you time and money on those trenching jobs. Its easy adaptability to other types of handling jobs makes it one of the most practical low-cost units ever built. It's as mobile as a tractor, too—providing three forward travel speeds, ranging from 1.3 m.p.h. to 5.2 m.p.h.

These all-purpose P&H machines are available for rent or sale, both new and used at attractive prices. It will pay you to write for full information on how easy it is to own or rent a P&H Back Filler. Send today for all the details. The Harnischfeger Corporation, 4404 W. National Avenue, Milwaukee, Wisconsin.

HARNISCHFEGER CORPORATION

EXCAVATORS · ELECTRIC CRANES · ARC WELDERS · P&H · HOISTS · WELDING ELECTRODES · MOTORS

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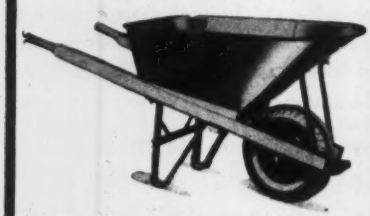
CONTRACTORS' WHEELBARROWS



S-18—FOR CONCRETE

Wheelbarrows for all contracting and industrial purposes.

Convenient Warehouse and Distributors Stocks

8

Sterling WHEELBARROW CO.
MILWAUKEE, WISCONSIN

Contractors *for placing* **"Gunite"** *and* **Pneumatically projected Concrete**

Allied Pneumatic Services, Inc.

347 Fifth Avenue N. Y. C.

Commonwealth of Pennsylvania and cause the suspension of reservoir building already undertaken and now in progress."

• • •

Mexico Approves Plans For International Bridge

Plans for building a larger international bridge over the Rio Grande between Nuevo Laredo, Mexico and Laredo, Texas, have been approved by the Mexican ministry of communications and public works. The ministry has assigned engineers to work out Mexico's share of the undertaking.

MEETINGS

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, San Francisco, July 26-28.

FIFTH International Conference on Timber Utilization, Zurich, Switzerland, Aug. 29–31.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual convention, Hotel St. Francis, San Francisco, July 26-29.

REGIONAL AND LOCAL

AMERICAN WATER WORKS ASSOCIATION, section meetings: Minnesota, Duluth, Aug. 24-25; West Virginia, Morgantown, Sept. 27-29.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS, summer meeting, Block Island and Narragansett Bay, R. I., July 27.

NORTH CAROLINA SOCIETY OF ENGINEERS, summer convention, Asheville, N. C., Aug. 4–5.

MINNESOTA Section, A.W.W.A., Duluth, Aug. 24-25.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Hotel Windsor, Montreal, Sept. 12-15.

SOUTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE, fifth annual meeting, Rapid City, Sept. 14-15.

NORTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE, Dickinson, N. D., Sept. 22-23.

• • •

License examinations

ALABAMA: applications for license for engineers and surveyors will be passed upon by the State Board of Registration at Birmingham, Aug. 11-12.